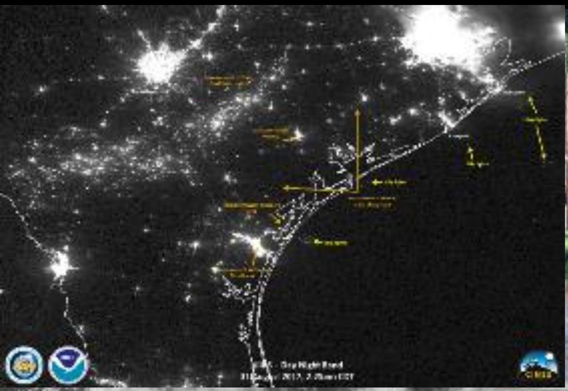
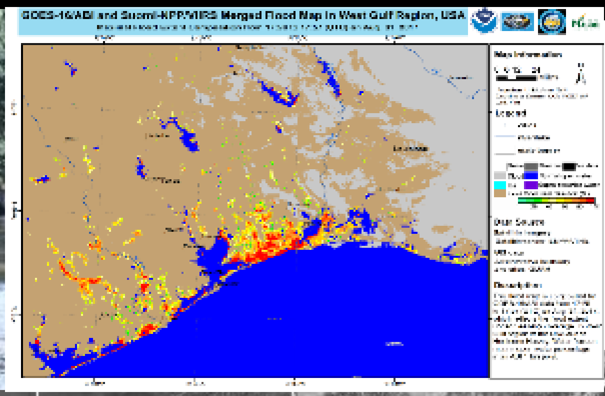
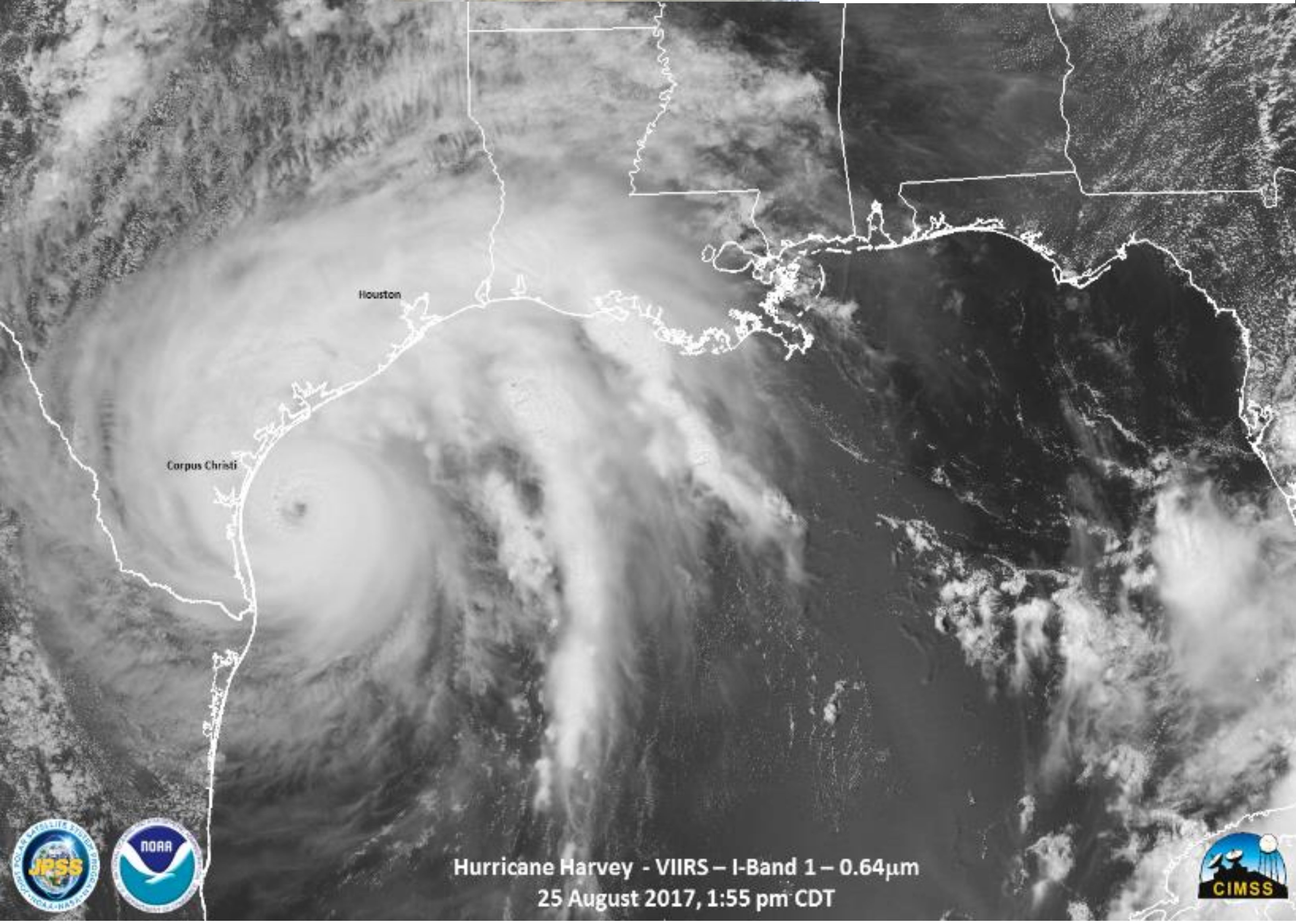
JPSS Proving Ground Portfolio

2018 - 2021







Cover page:

Top middle: Members of FEMA's Urban Search and Rescue Nebraska Task Force One (NE-TF1) comb a neighborhood for survivors impacted by flooding from Hurricane Harvey. Photo by FEMA News Photo - Aug 31, 2017. Accessed from: https://www.fema.gov/media-library/assets/images/135318

Top left: VIIRS Day/Night Band Image - Power Outages - 31 August 2017. Credit NOAA/CIMSS.

Top right: Integrated JPSS/GOES-R flood maps

Bottom: Image of Hurricane Harvey – the second-most expensive US hurricane on record – is captured by the VIIRS I-band, on 25 August 2017. Credit NOAA/CIMSS.

From the Scientists of the Joint Polar Satellite System (JPSS) and their Collaborators
Edited By: Dr. Mitch Goldberg, JPSS
Julie Price, Science and Technology Corporation (STC)
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INTRODUCTION

The Joint Polar Satellite System (JPSS) is a collaborative program between the National Oceanic and Atmospheric Administration (NOAA) and the National Aeronautics and Space Administration (NASA) that represents the Nation's most advanced fleet of operational polar-orbiting meteorological satellites. NOAA-20, the first of the JPSS constellation, launched into space on November 18, 2017. NOAA-20 capitalizes on the success of, and features similar instruments as, its predecessor the Suomi National Polar-orbiting Partnership (Suomi NPP) satellite. Suomi-NPP, a joint research mission between NOAA and NASA, was designed to bridge legacy NOAA polar-orbiting satellites and the JPSS generation. Prior to NOAA-20, Suomi NPP served as the primary polar-orbiting spacecraft supporting NOAA's most critical missions. The sequential launches of JPSS-2,-3, and 4, the remaining satellites in the JPSS constellation, will provide NOAA the critical JPSS capabilities to 2040.

JPSS satellites provide global observations of various environmental parameters including the atmosphere, ocean and land for short-term, seasonal and long-term monitoring and forecasting. JPSS provides these observations on an operational basis 24x7 and is expected to continue through the 2030's. The sensors include the Visible Infrared Imaging Radiometer Suite (VIIRS); Cross-track Infrared Sounder (CrIS); Advanced Technology Microwave Sounder (ATMS); Ozone Mapping and Profiler Suite (OMPS); and Clouds and the Earth Radiant Energy System (CERES).

Purpose of the Portfolio

The purpose of this portfolio is to provide summaries of projects selected during the 2018 Call for Proposals (CFP). The projects will begin in fiscal year 2018 with expected completion in 2021.

JPSS Proving Ground and Risk Reduction Background

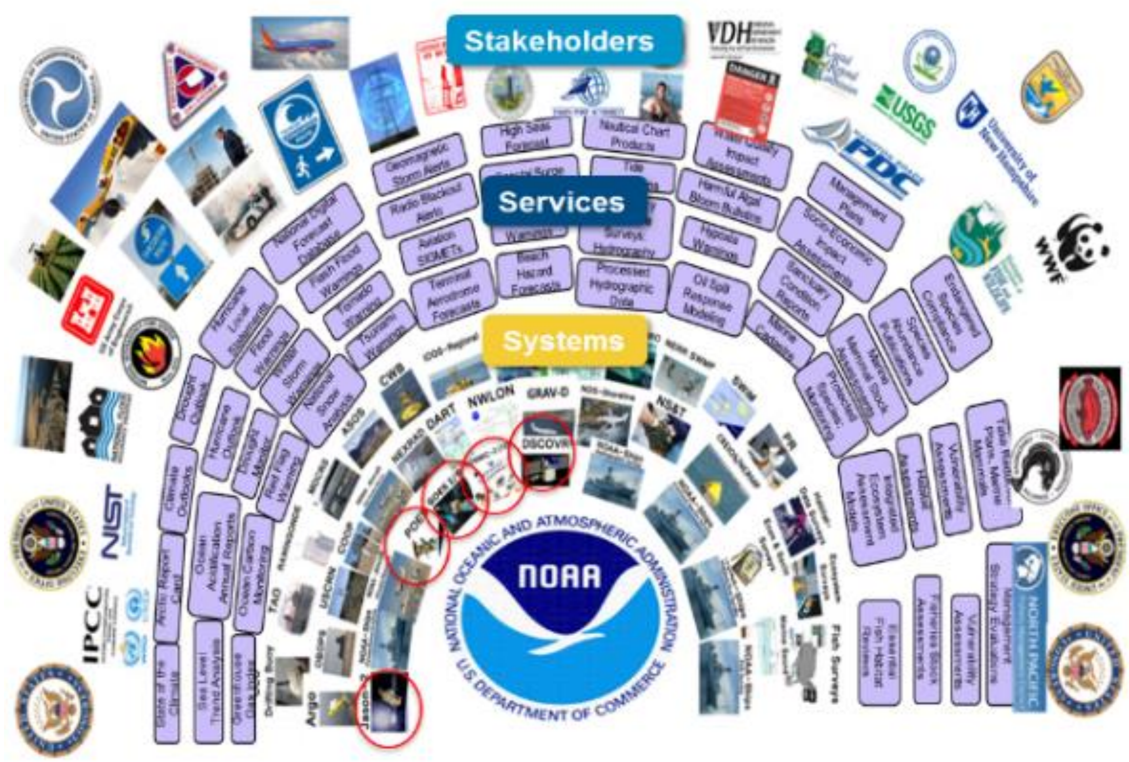
The JPSS Proving Ground and Risk Reduction (PGRR) Program was established in 2012, following the launch of the Suomi National Polar Partnership (Suomi NPP) satellite, to facilitate Operations to Operations (O2O) through demonstrations of JPSS derived data and products in user environments. It applies the science and technology provided by JPSS to user products and services (applications).

The Program focuses on maximizing the benefits and performance of data, algorithms, and products derived from Suomi NPP and JPSS for downstream operational and research users. The PGRR program provides resources and support to peer-reviewed projects which demonstrate improved operational application of JPSS data and products to assist NOAA and other agencies in meeting their mission requirements. The PGRR program now contains key data products and applications from other observing systems, including the GOES-R series. For example our Flood mapping application area now integrates data from GOES-R series Advanced Baseline Imager to provide users with integrated JPSS and GOES-R flood maps.

PGRR supports:

- Enhancements and improvements of user applications
- Education, Training and Outreach
- User collaboration to guide PGRR decisions and evaluate the implementation of these decisions
- Facilitation of transition of improved algorithms and user applications to operations.
- User feedback to the calibration/validation (cal/val) program

The Proving Ground component focuses on the demonstration and utilization of operational data products by end-users in NOAA's LOs in their operational and/or research environments, leading to innovative applications and identification of new capabilities. The Proving Ground also promotes outreach, training, and coordination of new products with the end users.



Systems to Services to Stakeholders

The Risk Reduction component focuses on the development of new research and applications to maximize the benefits of JPSS satellite data. It allows for testing alternative algorithms and developing new research and applications as well as the fusion of data/information from multiple satellites, models, and in-situ sources.

The development of the Community Satellite Processing Package (CSPP) for direct readout capabilities has become a cornerstone of a number of PGRR Projects. CSPP utilizes open source science software to package and distribute meteorological and environmental satellite data through Direct Broadcast (DB). The JPSS component of CSPP transforms VIIRS, CrIS, and ATMS data from NOAA-20 and Suomi NPP into optimal formats for real-time processing and regional applications. CSPP Software is available from NOAA's Cooperative Institute at University of Wisconsin and Direct Readout Lab. NOAA funds a network of direct readout antennas across the Pacific, North America, and the Caribbean. Data from these antennas are applied directly in real time operations, or used to create products for real time applications. Direct Readout enables much faster delivery of real-time imagery and selected derived products to forecasters, thereby accelerating their forecasting capabilities.

Thematic Project Areas

An objective of the PGRR program is to improve NOAA Services through optimizing the use of satellite data along with other sources of data and information. Since 2012, the program has issued Calls for Proposals (CFPs) to fund projects focused on applications and decisions support for NOAA service areas as well as those of its partners.

The inaugural CFP focused on innovative use of science applications and products from Suomi NPP. Forty projects were funded from this CFP, and they developed products to support applications in regional and global weather forecasting; tropical cyclones; hazards such as smoke, fire, volcanic ash, air quality; ocean/coastal; hydrological; data assimilation, and imagery/visualization. In December 2014, the second CFP was issued. This CFP focused on maximizing the use of existing products in operations. Over 40 new projects were selected for funding in application areas including forecasts and warnings of fire and air quality, warnings and prediction of poor water quality in coastal regions, and drought, precipitation, snow and ice assessments and predictions. Starting with the 2014 CFP the PGRR transitioned from individual project management to Proving Ground Initiatives (PGI) enabling more collaboration and synergy between projects.

Addressing needs across NOAA

The initiatives comprise of developers and users working together in multi-disciplinary 'hands on' environments to improve product applications. These environments provide a hub for users to assess products and deliver feedback to the developers for further improvements if needed.

The 2017 CFP, released on October 13, 2017, resulted in the selection of 45 new and continuing projects. This call also included the generation of products derived from VIIRS and ATMS on NOAA-20 as well as the second Advance Microwave Scanning Radiometer (AMSR2) operating onboard the Japan Aerospace Exploration Agency's (JAXA) first satellite in the Global Change Observation Mission - Water (GCOM-W1) series.

Past successful applications explored low data latency via direct broadcast, enabling forecasters and modelers to have access to data that otherwise would become perishable. Following these successes, exploration of low latency dissemination via direct broadcast to deliver data to regions which may lack conventional in-situ or upper air observations has become an integral element of the PGRR Program. Some past projects explored multi-sensor or fusion approaches for better temporal coverage. For the new projects, an important and common feature is the exploitation of the 50 minute separation between Suomi NPP and NOAA-20. Now overlapping imagery is available more quickly than having to wait for a single satellite to complete a full orbit, which is roughly 102 minutes. Another advantage to having twin satellites operating close to each other is the opportunity to collect more detailed data from multiple instruments.

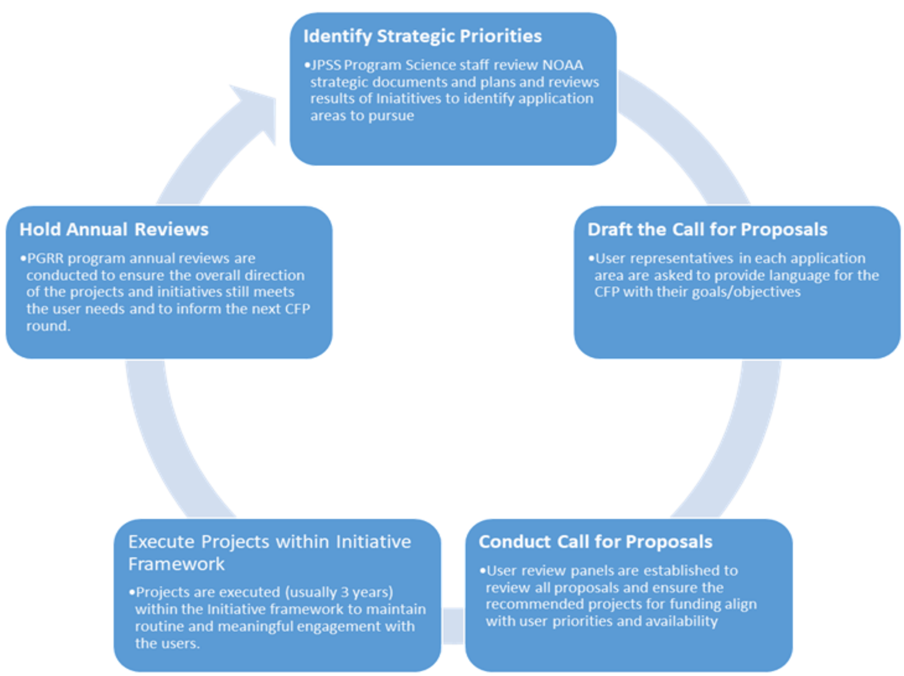
Putting essential data in the hands of the user community and stakeholder groups is a fundamental activity of the PGRR. To this end, some past projects, for example, VIIRS active fires, explored data portals as a means to provide convenient, secure access to large sets of data. Some new projects will explore portals for air quality and regional ocean color satellite data.

The 2018 projects are structured into the following PGIs:

*Blue denotes new Initiatives from the PGRR 2017 Call For Proposals.

How Priorities are set in the Proving Ground

From the very beginning of the JPSS program, the Low earth-Orbiting Requirements Working Group (LORWG) has been the group that has not only set the data product requirements for the program but also but has provided the PGRR program with their user application priorities focused on the application/service area which would best benefit from a concerted effort to better utilize JPSS data and products. In the case of NWS, their LORWG representatives collaborates with the NWS Operational Advisory Team (NOAT) to help set NWS priorities. In addition to the priorities set by the users, PGRR also works to connect the PGRR priorities with the NESDIS or NOAA strategic plans, policies, and/or objectives. For example in the Arctic application area, the PGRR program ensures alignment with the NOAA Arctic Action Plan efforts. The PGRR program priorities are defined or refined every 3 years through the Call for Proposals (CFP) process. The CFP process is used to select and fund individual projects. LORWG representatives contributed significantly to the development of the three PGRR CFPs and participated as members of the teams reviewing proposals and providing recommendations to the JPSS Program Office. In addition to LORWG members, the CFP review panel is comprised of user community subject matter experts in the application areas. During the execution of the projects, the PGRR Program hosts annual reviews to ensure the overall direction of the projects continues to support and align with the user priorities. These users are also a key part of the management of the PGRR Program by their active participation in the following process.



Proving Ground Initiatives

Who We Are - Overview

The JPSS PGRR Program has adopted an organizational structure that uses "initiatives" to bring individual projects together in a collaborative environment to achieve common objectives. These PGRR Initiatives (PGI) Teams bring together, JPSS representatives, data product developers, operational users, and training personnel. The teams engage users and service providers to better understand their applications and operational requirements, and to work together to improve their utilization of current and experimental satellite products. The objective is to provide the tools to mitigate the impacts of environmental disasters and increase the societal benefits of these satellite capabilities. Feedback from the users often result in improvements to our operational products and or the identification of new areas of research. Each initiative focuses on a NOAA application/service area theme.

Inception of new science activities is channeled through existing or new Initiatives and starts with: (1) meetings with the users to ensure objectives and actions are well defined, and (2) endorsements by the user advocates from the line offices and service areas in support of the PGI outcomes (e.g. new products, operational applications, core competencies needed by key core applications, etc.). The JPSS PGI program coordinates with the overarching scientific community, developers, users and NOAA line offices in achieving the objectives set forth for each Initiative.

We also support a core team providing cross-cutting support to all of the initiatives to help NOAA users with improved access, training, and utilization of satellites products for their applications. So even when an Initiative has only one project, such as the Arctic and Aviation, there is still a team working with users to support data access, utilization, training and feedback.

The Initiatives are facilitated by a coordinator from JPSS Program Science who works with a senior NOAA user advocate to ensure that projects utilize JPSS data in ways that ultimately lead toward the demonstration of improved applications. They work together to establish and maintain the functions of each initiative in ways that best serve the team.

Coordinator

The coordinator facilitates the initiative's activities. They help the initiative team formulate initial objectives and actions needed to meet those objectives. They schedule initiative meetings, ensure access to briefing material, and capture and status action items. The coordinator may also help establish ad hoc sub-groups that focus on particular aspects of the initiative objectives and assists these sub-groups in achieving successful conclusions. The coordinator works with the initiative team to determine how to communicate results to the JPSS Program Scientist, PGRR Executive Board and JPSS Leadership. The initiative team also communicates key project details through outreach to internal and external stakeholders and the public.

User Advocate

The user advocate provides leadership for all users participating in a particular initiative. While this advocate may represent a typical user or segment of the user base, he or she must also be able to assimilate a variety of user concerns into coherent messages. To do this, the advocate establishes procedures to:

- Share user feedback with the product development teams to ensure that users' needs are evident
- Help evaluate, test and analyze in-process product changes, and suggest modifications based on user expertise
- Help educate users about the products and cross-sell them when appropriate

What We Do

Our project activities are centered upon NOAA operational focus areas and they aim to address forecast and mission support challenges. In addition, we explore a broad range of research areas in NOAA, and also support mission areas in other agencies. For example, NWS River Forecast Centers have shared our flood mapping products with agencies such as FEMA and the U.S. Army Corps of Engineers, models assimilated with the VIIRS Fire Radiative Power data are being utilized by agencies such as the U.S. Forest Service and the EPA in air quality applications. Other products have been utilized by the U.S. Department of Defense for security applications and the USDA in agricultural applications. Experiments with current products in some of the focus areas have led to the creation of new applications. Initiative sub-groups are formed to determine what actions need to be taken to study applications and how best the PGRR Program can respond. JPSS products and /or capabilities are evaluated to ensure their optimal use in the user environment. But more importantly, they are evaluated to ensure that they are effective and contribute to challenges identified by the user. Subsequently, actions to transition these capabilities to user operations are identified and implemented.

How We Work

Certain procedures have served as best practices for all the initiatives. However, there is a measure of uniqueness to how each Initiative is managed, as well as variation in scope, scale, and approach.

Each Initiative sets well-defined goals and objectives, and ensures that specific actions meet these objectives. Initiatives must maintain focus on increasing the usage and function of JPSS data products and other key observations (e.g. GOES-R) when applicable in operations, particularly for NOAA users. Active engagement between algorithm developers and NOAA stakeholders enables users to evaluate products and capabilities in operational environments, and algorithm developers to implement improvements tailored to satisfy users' requests. This format has proven successful in carving a path for these capabilities to be efficiently transitioned to day-to-day operations. This includes the demonstration of JPSS derived products in the end-user environment, and their subsequent utilization, and user engagement to assess the impact of JPSS products on user applications (e.g. weather forecasting, flood forecasting and mitigation).

ARCTIC INITIATIVE

MOTIVATION:

Polar-orbiting satellites are critical for environmental monitoring and forecasting in the Arctic, where conventional observations are limited. The poles, more than any other part of the planet, receive more passes from polar-orbiting satellites, which pass near or directly over them on each orbit. With the JPSS constellation (NOAA-20 and Suomi NPP) in orbit, the Arctic benefits from 28 passes per day from the pair. The JPSS pair provide approximately hourly observations of the cryosphere. JPSS satellites enable the production of many data products, including sea ice concentration, snow cover and depth and other atmospheric and oceanic observations, which are critical for safe and productive use of the Arctic environment for economic gains and national security interests. Following the releases of the U.S. National Strategy for the Arctic Region and its subsequent Implementation Plan in 2013 and 2014, respectively, NOAA drafted an Arctic Action Plan that also outlined its Strategy and Vision, which includes goals for forecasting sea ice; improving weather and water forecasts and warnings; strengthening foundational science to understand and detect Arctic climate and ecosystem changes; improving stewardship and management of ocean and coals resources; advancing resilient Arctic communities and economies; and enhancing international and national partnerships. The evidence of changing Arctic sea ice conditions is extensive. Observing the Arctic is complicated by its remoteness and inaccessibility. More than that, the region has scarce and unevenly distributed conventional observation resources, which makes satellite observations the only feasible means of collecting information Arctic-wide. According to the 2017 NOAA Arctic Report Card, sea ice cover continues to be relatively young and thin with older, thicker ice comprising only 21% of the ice cover in 2017 compared to 45% in 1985. This melting and thinning of the sea ice cover will have impacts on a variety of commerce and transportation activities in the Arctic. As the Arctic environment changes, so will the growing demand for environmental intelligence.

WHO WE ARE

The JPSS Arctic Initiative began in June 2016 with a nine-member team. Presently, we have close to 30 members who continue to offer insights to consumers of JPSS data products to create better and more informed outcomes for the Arctic region. Members include the Geographic Information Network of Alaska (GINA), Center for Satellite Applications and Research (STAR), the NWS Alaska Region, the National Ice Center (NIC), the Cooperative Institute for Research in the Atmosphere (CIRA), the Cooperative Institute for Meteorological Satellite Studies (CIMSS), and the U.S. Arctic Observing Network (US AON).

WHAT WE DO:

The initiative's purpose and objectives are as follows:

I. work with the NOAA/NWS Alaska Sea Ice Program (ASIP) and the NIC to improve sea ice monitoring and forecasting;
II. establish cryosphere products in use in Alaska;
III. prioritize and establish interactions with forums supporting initiatives in the Arctic;

IV. align JPSS initiatives – including Fire and Smoke, River Ice and Flooding, and NUCAPS – in the Arctic with the NOAA Arctic Plan; and
V. align with international groups including the WMO Polar Space Task Group, WMO Global cryosphere watch, as well as other NOAA efforts such as JPSS PGRR initiatives.

The Arctic Initiative unites product developers, consumers, and stakeholders of JPSS data products to increase their use in applications, and, more importantly support decision-making in the Arctic. Members of the Initiative also engage in partnerships where joint action is needed.

JPSS aims to demonstrate the use of sea ice products for monitoring and forecast applications in user environments and work with user communities to understand how these applications support commerce and transportation in the Arctic. Ultimately the Arctic Initiative has set a goal to identify need areas and integrate JPSS data into operations. Ideally this will increase or improve the use and value of cryosphere data products in user products, services, and application or service areas.

Focus Areas:

- To meet user needs, our activities focus on the cryosphere with an emphasis on sea ice forecasting, river and lake ice and snow; and weather, which includes real time and aviation weather forecasting. For land applications we focus on permafrost and oil exploration; and last but not least, we engage the fisheries community through efforts centered on fish location in relation to SST or ice cover as well as the location of fishing vessels.
- Through partnerships with the NWS ASIP, the NIC, NWS/NCEP, and others we seek to improve sea ice monitoring, modeling, and forecasting using existing JPSS data products (e.g., VIIRS sea ice concentration, VIIRS ice age/thickness, VIIRS snow cover, VIIRS ice surface temperature, and snow-ice products from microwave-based instruments, ATMS and AMSR-2).

WHO WE WORK WITH

Currently our biggest consumers are the NWS Alaska Sea Ice Program and the U.S. National Ice Center. Both programs require many satellite data products to fulfill their missions of providing Arctic-based and global sea ice analysis and forecasting.

WHEN WE MEET

Our events offer an opportunity for product providers, developers, and consumers with an interest in the Arctic to learn and participate in our work. We meet once a month through teleconference and in addition, select products are provided and evaluated in a demonstration, which gives us an opportunity to engage analysts and forecasters and demonstrate our data products as well as features that tie directly to their challenges. The demonstration also provides an opportunity for algorithm provider(s) to receive feedback on product utility.

In the most recent Arctic Initiative Demonstration, several ice-related products from Suomi-NPP were showcased to analysts and forecasters at the ASIP and the NIC. The products were evaluated by the sea ice analysts, and feedback in many areas including usefulness, formats, display enhancements/modifications were provided.

MAJOR ACCOMPLISHMENTS

Successful product demonstration held within the ASIP in the spring of 2018. A second demonstration was held from November 2018 – January 2019 and included ASIP and the NIC.

PROJECT(S):

Our projects address the unique needs in the Arctic region, approach, and relevance to PGRR goals/priorities.

The following section presents a summary of our project “**Ice Motion from VIIRS, AMSR2, and SAR – Development and Operational Applications**”.

Ice Motion from VIIRS, AMSR2, and SAR –Development and Operational Applications

Yinghui Liu, Jeffrey Key, Aaron Letterly, Sean Helfrich, Christopher Jackson, and David Santek

WHY IS THIS RESEARCH IMPORTANT?

Knowledge of the characteristics of sea and lake ice is critical to navigation in ice-covered waters. One important property of the ice pack is its motion. Sea ice motion can be obtained more or less directly by tracking drifting ice buoy positions, such as those of the International Arctic Buoy Programme. However, buoys are sparsely distributed and hence do not provide a comprehensive view of motion in Arctic Ocean or the Southern Ocean around Antarctica. Furthermore, there is no robust network of buoys in inland waters such as the Great Lakes. For a comprehensive picture of large-scale and small-scale motion, satellites are needed.

GOAL: To further develop the ice motion products from individual sensors, create new blended motion products, and implement and test the products in (near-) real-time operations. And, to investigate and prototype a relatively simple short-term ice motion forecast product, based on the derived ice motion vectors and a model surface wind field.

RATIONALE: Many products, including those from satellite passive microwave sensors have helped keep track of sea ice. However, these sea ice motion products are usually done over a long time scale (on the order of a couple of days) due to the low resolution of the microwave sensors (approximately 13 km/pixel). Therefore, to make this product available in near real-time, the use of high spatial and temporal imager data is required.

OUTCOMES: Near-operational, individual and blended ice motion products based on VIIRS, AMSR2, and SAR that have been thoroughly tested by users in operational or pseudo-operational applications will be generated routinely.

Additionally, a simple, short-term ice motion forecast product will be developed, tested, and routinely generated.

REFERENCES

Emery, W., C. Fowler, and J. Maslanik. 1995. Satellite Remote Sensing of Ice Motion, in Oceanographic Applications of Remote Sensing, ed. Motoyoshi Ikeda and Frederic W. Dobson. CRC Press, Boca Raton.

Emery, W. J., C. W. Fowler, J. A. Maslanik, 1997. Satellite-derived maps of Arctic and Antarctic sea ice motion: 1988 to 1994, J. Geophys. Res. Lett., 24(8):897-900.

Liu, Y., J. Key, and X. Wang, 2009: Influence of changes in sea ice concentration and cloud cover on recent Arctic surface temperature trends. Geophysical Research Letters, 36.

Miller, S.D., Mills, S.P., Elvidge, C.D., Lindsey, D.T., Lee, T.F., Hawkins, J.D., 2012. Suomi satellite brings to light a unique frontier of nighttime environmental sensing capabilities. PNAS, 109(39), 15706–15711.

Meeting Participants

Name	Organization
Helfrich, Sean	
Petrescu, Eugene	Acting Alaska ESSD Chief and in charge of the Arctic Testbed
Fish, Amiee	AK Fire Weather
Mazur, Rebecca	Arctic Testbed
Lawson, Michael	ASIP Sea Ice Analyst/forecaster
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Ferraro, Ralph	Center for Satellite Applications and Research (STAR)
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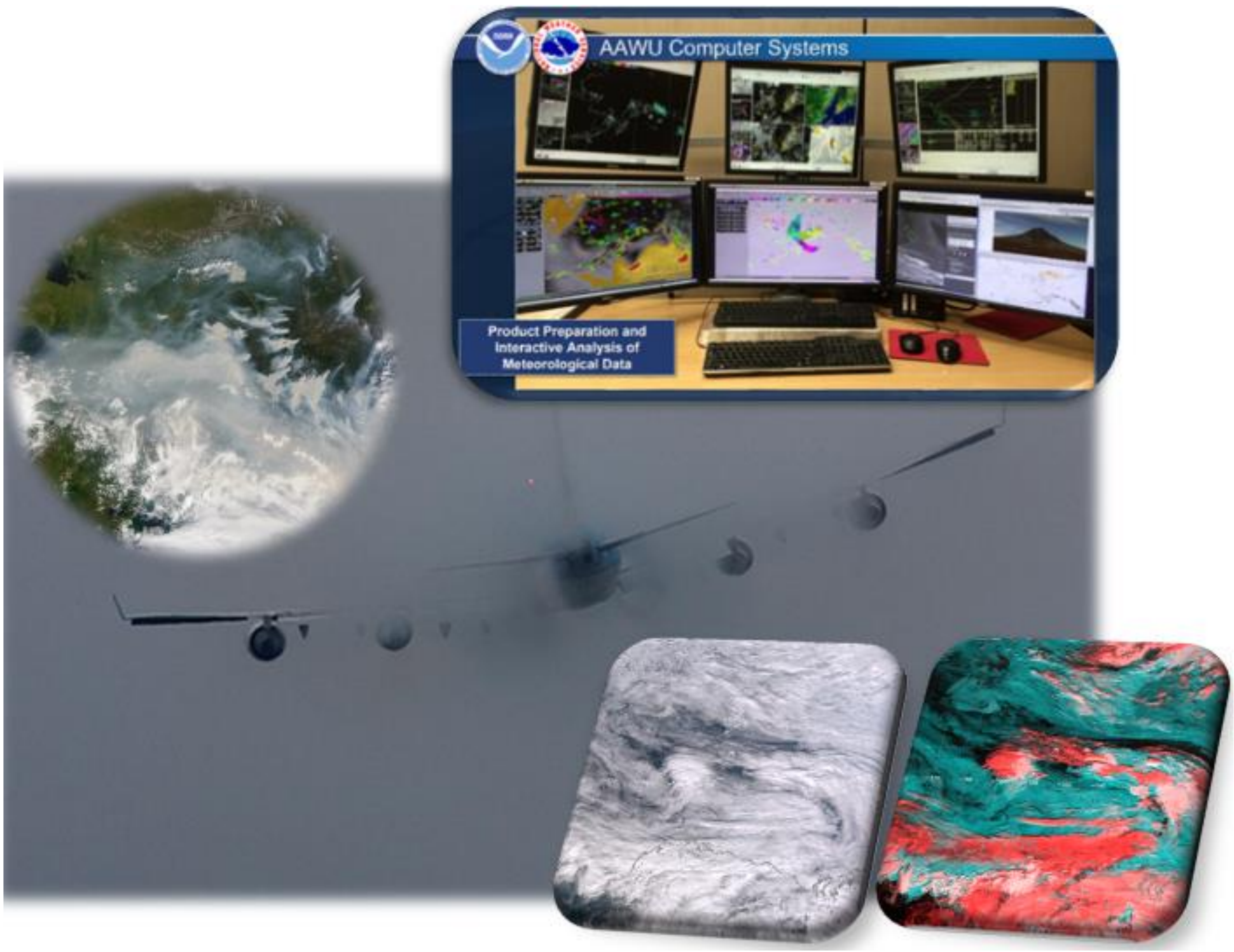
Stevens, Eric	Geographic Information Network of Alaska (GINA) Science Liaison and Meteorologist
Tatusko, Renee	International and Arctic Policy Coordinator NOAA National Weather Service, Alaska Region Hq
Weinrich, Jeff	JPSS Algorithm Management Project Cal/Val lead and Aviation Initiative Coordinator
Layns, Arron	JPSS Algorithm Management Project Lead
Reed, Bonnie	JPSS Product Systems Engineer
Sjoberg, Bill	JPSS Program Office
Goldberg, Mitch	JPSS Program Scientist
Kreller, Melissa	National Weather Service Alaska Region - Training Coordinator
Scott, Carven	National Weather Service Alaska Region Director
Woods, John	NIC - Snow/Ice PAL
Starkweather, Sandy	NOAA/CPO, Executive Director - US Arctic Observing Network (US AON)

Eckstein, Nathan	NWS AK Region HQ
Heim, Rebecca (Becki)	Regional Program Manager - NOAA/NWS Alaska Region
Seaman, Curtis	Research Scientist, Cooperative Institute for Research in the Atmosphere (CIRA)
Torres, Jorel	Research Scientist, Cooperative Institute for Research in the Atmosphere (CIRA)
Schreck, Mary-Beth	Sea Ice Analyst, National Weather Service, Alaska Sea Ice Program (ASIP)

AVIATION INITIATIVE



This initiative focuses on inclusion of the high resolution JPSS data and products in aviation weather forecasts. The figures at the bottom on the right are Day Arctic Cloud Type RGB that uses the 1.38 and 1.6 micron to highlight cirrus and ice/water differences. They are very effective in the Arctic where it can be challenging to distinguish snow/Ice surfaces from clouds from most imagery.

MOTIVATION:

According to the Federal Aviation Administration (FAA), weather is the largest cause of air traffic delay in the National Airspace System (NAS) accounting for 69%. Weather-related delays totaled nearly 10 million minutes in 2013. The FAA estimates that currently, the cost to air carrier operators for an hour of delay ranges from about $1,400 to $4,500, depending on the class of aircraft, and whether the delay occurs on the ground or in the air. If the value of passenger time is included, the cost goes up an additional $35 per hour (personal travel) or $63 per hour (business travel) for every person on board.

The FAA leads the multi-agency Next Generation Air Transportation System (NextGen), an effort to modernize the United States air transportation system to make flying even safer, more efficient, and more predictable. FAA collaborates with NWS Aviation Weather Centers and other operational centers to provide fast, reliable access to advanced weather products and flight planning tools, and forecast products. A broad community of users, including pilots, dispatchers, and Flight Service Station briefers use this information. Currently sensor inputs to weather ingest systems include conventional surface observations such as Automated Weather Observing Systems (AWOS), Automated Weather Sensor Systems (AWSS), and Lightning sensors. Other direct inputs include Terminal Doppler Weather Radar (TDWR) and Low Level Wind Shear Alert System (LLWAS), Next Generation Weather Radar (NEXRAD), and both east and west Geostationary. *Part of the motivation of this initiative is the exploration of incorporation of JPSS data and products for aviation weather forecasts improvements.*

In aviation, ceiling is a measurement of the height of the base of the lowest clouds that cover more than half of the sky relative to the ground. NWS Government Performance and Results Act measures for aviation weather include Accuracy for the zero- to 6-hour aviation forecasts for ceiling and visibility (combined). Instrument flight rule (IFR) conditions are defined as whenever the ceiling is below 1,000 feet or the visibility is below 3 statute miles. Use of cloud data and products is particularly relevant for IFR conditions.

WHO WE ARE

The JPSS Aviation Initiative began in March 2018 with a 5-member team. Presently, we have close to 25 members who continue to offer insights to consumers of JPSS data products to create better and more informed outcomes for the Aviation community. Members include the Geographic Information Network of Alaska (GINA), Center for Satellite Applications and Research (STAR), the NWS Alaska Region, Alaska Aviation Weather Unit (AAWU), Federal Aviation Administration (FAA) Flight Service, NWS Center Weather Service Unit (CWSU), Environment Canada, and private pilots.

WHAT WE DO:

Currently our efforts are pathfinding and foundational work. Pathfinding efforts focus on return on investment and optimizing use of these cloud products to discern atmospheric conditions with the potential for aircraft icing hazards. This information in turn is used in aviation weather decision support systems. NWS and Office of Oceanic and Atmospheric Research (OAR) user inputs to NOAA's Low-Earth Orbiting Requirements Working Group (LORWG), part of the NOAA Observing System Council (NOSC), assessed cloud layers, mask, optical depth, cloud top temp and pressure to be high impact products for aviation weather.

Work for this initiative includes establishing a user and stakeholder base. This builds upon existing collaborations with product developers within NOAA NESDIS, users within NWS and FAA, Department of the Interior and other organizations and researchers in organizations such as the NOAA OAR, NCAR, MIT's Lincoln Laboratories, NASA and governmental coordination organizations such as the OFCM, OSTP, the International Civil Aviation Organization (ICAO), and others.

Cloud Product Demonstration

Another important activity planned for later in 2018 is a Cloud Product Demonstration. This demonstration will be conducted with JPSS cloud products processed by the Geographic Information Network of Alaska (GINA) in Fairbanks, Alaska. GINA will use DB data from both Suomi NPP and NOAA-20 to provide products with the lowest possible latency. The products will come from the NOAA Enterprise Algorithms generated within the Community Satellite Processing Package (CSPP). The product set will include cloud-top altitude, cloud cover layers, cloud ceilings and super-cooled droplet probability. The users will be the Alaskan aviation community which includes the National Weather Service (NWS) Alaskan Aviation Weather Unit (AAWU) and other relevant bodies. The goal will be to educate and to elicit feedback on the utility of the JPSS cloud products to the Alaskan aviation community and to explore integration of these products into their existing tools and applications. Future instances of this demonstration will broaden to include other regions.

Aviation weather forecast using storm scale models such as the High Resolution Rapid Refresh Model (HRRR) is not a near term focus of this initiative, although cloud products have the potential for assimilation into models. HRRR projects are also addressed in other initiatives to include, Fire and Smoke, Numerical Weather Prediction Impact Studies and Critical Weather Applications, and Volcanic Ash.

Focus Areas:

Our efforts during the FY 2018-20 period of performance will focus on high latitude weather. The Suomi NPP and N20 constellation along with direct broadcast capabilities allows the Alaska Region to receive high resolution, low temporal latency cloud data for 28 daily overpasses. This provision of perishable satellite data enables forecasts and watches and warnings for rapidly evolving weather. This polar data is especially important at higher latitudes, such as the Alaska Region which is data sparse both for conventional observations and geostationary observations.

- Aviation watches and warnings
- Aviation weather forecasts for high latitudes
- Nighttime applications

WHEN WE MEET

The Aviation Initiative meets once a month via a teleconference. The vast group of users discuss their wants and needs for weather subject areas. Users also give feedback to JPSS Data Products through Demonstrations. The technical experts find solutions and recommend products that may be useful to the stakeholders.

MAJOR ACCOMPLISHMENTS

- Training Quick Guides created for JPSS Cloud Products.
- Live Training given to users by JPSS cloud experts.
- Website created for non AWIPS users to download JPSS Cloud Products.
- Projects plan created for JPSS Cloud Product Demonstration

PROJECT(S):

The following section presents a summary of our project "**Improving the VIIRS Nighttime Cloud Base Height and Cloud Cover Layers Products for High Latitude Weather and Aviation Forecast Applications**".

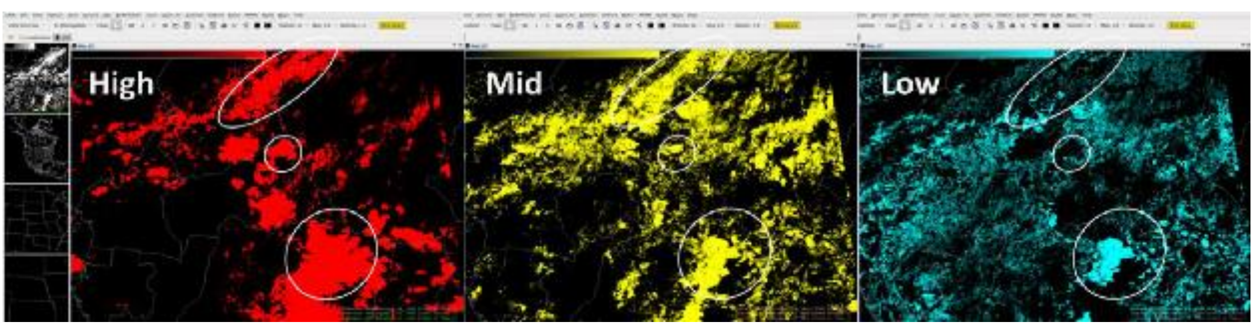
Improving the VIIRS Nighttime Cloud Base Height and Cloud Cover Layers Products for High Latitude Weather and Aviation Forecast Applications

Yoo-Jeong Noh, Steven D. Miller, John M. Haynes, John M. Forsythe, and Curtis J. Seaman

WHY IS THIS RESEARCH IMPORTANT?

Information on the 3-D structure of clouds is of significant practical relevance to the aviation community and critical to integrating cloud radiative feedbacks within numerical models. Although satellite remote sensing with passive radiometers has conventionally provided a ready means to estimating various cloud properties, the information has been biased toward cloud top owing to sensitivity, and assignment of cloud base and vertical layers is inherently challenging. Given its importance, the aviation community and operational users (e.g., the NWS Operational Advisory Team [NOAT]) have issued a requirement for global retrievals of CBH from satellite platforms. Among various research efforts to derive CBH, the JPSS Program selected an algorithm based on Hutchinson [2002] and Hutchinson et al. [2006] to serve as the official VIIRS Environmental Data Record (EDR) to be produced through the Interface Data Processing Segment (IDPS, hereafter referred to as the "IDPS CBH"). This became the first operational global retrieval of CBH from passive visible and infrared satellite observations.

GOAL: continue to improve the Visible Infrared Imaging Radiometer Suite (VIIRS) Cloud Base Height (CBH) and Cloud Cover/Layers (CCL) products at night, supporting the NOAA Strategic Goals of Weather-Ready Nation objective to "Improve weather decision services for events that threaten lives and livelihood" as well as the Arctic Action Plan to "Improve weather and water forecasts and warnings and advance resilient Arctic communities." CBH is a key parameter in constructing a 3-D cloud field which bears high relevance to the aviation community. Below is an example of the improved VIIRS layer cloud fractions implemented at CIRA into AWIPS II. The white-circled areas in the figure contain additional cloud information that was not available in the previous CCL algorithm which only had knowledge about cloud top height and no means to specify the vertical extent of the cloud.



AWIPS II display of the VIIRS Cloud Cover Layers products (11 May 2016 at 1202 UTC) improved by using the cloud base information (white circles).

RATIONALE: Despite previous accomplishments with CBH/CCL products, multi-year validation against active satellite sensors like CloudSat and CALIPSO has emphasized the need for further algorithm refinements to include:

- The performance of the current CBH retrieval is highly dependent on the accuracy of the upstream cloud mask used as input for the algorithm. The CBH algorithm operates on pixels determined to be ‘cloudy’ or ‘probably cloudy’ by the VIIRS Cloud Mask. False/missed cloud by the VIIRS cloud mask will be inherited by the CBH algorithm.
- Uncertainties in upstream retrievals of CTH and CWP will directly impact the accuracy of CBH estimates. Through daytime validation using CloudSat and CALIPSO, the current CBH algorithm meets the VIIRS requirements for precision and accuracy (2 km for CBH) when CTH is within an accurate range (“within spec”). But inaccurate upstream cloud retrievals may result in CBH failing to meet specification.
- The CBH algorithm also relies on upstream cloud optical properties for CWP as well as CTH. As the lack of visible band reflectance limits sensitivity, CWP is difficult to retrieve at night, and thus the nighttime CBH retrieval performance is degraded relative to the daytime retrievals.
- Validation of night-time CBH has been complicated by a CloudSat battery anomaly that has resulted in daytime-only operation since 2011. The accuracy of NWP data, currently used as supplementary data to provide the nighttime CWP information, may add uncertainties to CBH estimates at night.
- Multi-layered cloud systems present challenges to the VIIRS retrievals of CTH and cloud optical properties. Since the current CBH algorithm has been optimized for single layer clouds (or the uppermost layer of multi-layered clouds by utilizing other upstream cloud properties) the accuracy of the CBH and CCL products for multi-layer clouds will be degraded. The CBH and CCL products should be used with caution in regions where multi-layered clouds are present. Further research for the characteristics of the algorithm performance for multi-layered clouds is needed.

Precipitating clouds present a source of uncertainty to the CBH algorithm. Since there is no effective way to determine the cloud base in the presence of precipitation using CloudSat data, these clouds must be filtered out using other CloudSat-products, predicated on path-integrated attenuation thresholds. Any precipitating clouds that this filter misses will contaminate the algorithm statistics and lead to overestimates in CGT.

OUTCOMES: Effective nighttime retrievals, especially during the winter months at high latitudes where VIIRS plays an important role in gap-filling due to the lack of high-resolution geostationary coverage.

REFERENCES

Seaman, C. J., Y. J. Noh, S. D. Miller, A. K. Heidinger, and D. T. Lindsey, 2017: Cloud base height estimation from VIIRS. Part I: Operational algorithm validation against CloudSat. J. Atmos. Ocean. Tech., 34(3), 567-583.

Noh, Y. J., J. M. Forsythe, S. D. Miller, C. J. Seaman, Y. Li, A. K. Heidinger, D. T. Lindsey, M. A. Rogers, and P. T. Partain, 2017: Cloud base height estimation from VIIRS. Part II: A statistical algorithm based on A-Train satellite data. J. Atmos. Ocean. Tech., 34(3), 585-598, doi: 10.1175/JTECH-D-16-0110.1.

Hutchinson, K., 2002: The retrieval of cloud base heights from MODIS and three-dimensional cloud fields from NASA's EOS Aqua mission. Int. J. Rem. Sens., 23 (24), 5249-5265.

Miller, S. D., S. P. Mills, C. D. Elvidge, D. T. Lindsey, T. F. Lee, J. D. Hawkins, 2012: Suomi satellite brings to light a unique frontier of nighttime environmental sensing capabilities. P. Natl. Acad. Sci., 109(39), 15706-15711

Meeting Participants

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Robert Griffin	Environment Canada
Sophie Splawinski	Environment Canada
Brian Waranauskas	FAA Command Center
Andrew McClure	FAA Flight Service
David Barber	Federal Aviation Administration (FAA)
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Bonnie Reed	JPSS/STC
Jeffrey Weinrich	JPSS/STC
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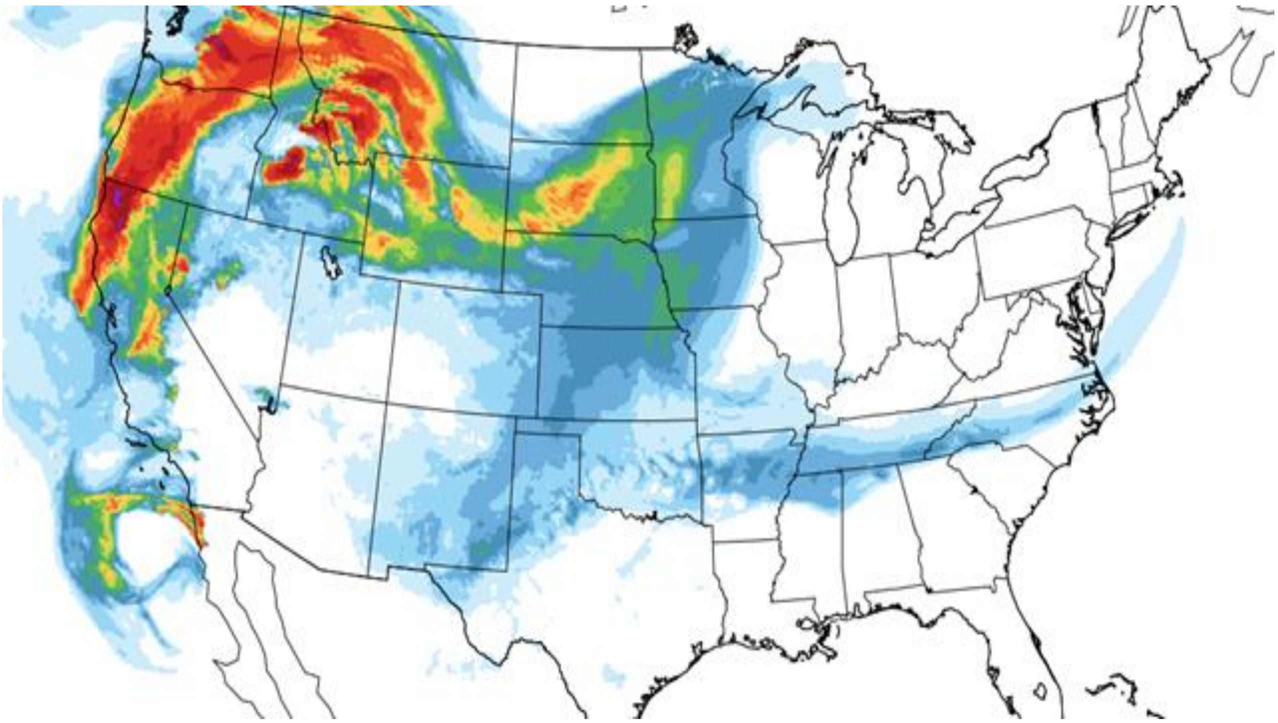
Nadia Smith	STC
Jorel Torres	The Cooperative Institute for Research in the Atmosphere (CIRA)
Jay Cable	The Geographic Information Network of Alaska (GINA)

FIRE AND SMOKE INITIATIVE



Wildfire HRRR-Smoke Model Map September 4, 2017. Credit: Ravan Ahmadov. Heavy smoke continues to spread across northwest and north-central US, https://rapidrefresh.noaa.gov/hrrr/HRRRsmoke/

MOTIVATION:

A fire event can have far-reaching consequences on the environment, including ecosystem change, and permanently altered landscapes. Fires can have a variety of negative effects on weather and climate through both regional and global scale alteration of atmospheric composition. Smoke emissions reduce air quality and represent a major health hazard. In the human/urban interface in particular, fire events pose dangers to life as well as the potential for property loss. According to an article titled, "Wildland Fire Smoke and Human Health," published in the December 2017 issue of Science of the Total Environment, wildland fire smoke exposure is an important and growing risk to public health[1].

The NOAA Smoke Forecasting System was built to provide guidance to air quality forecasters and the public for fine particulate matter emitted from large wildfires and agricultural burning which can elevate particulate concentrations to dangerous levels. The graphic on the previous page shows smoke projections using initial conditions from the High-Resolution Rapid Refresh (HRRR) 36-hour smoke forecast assimilated with the JPSS VIIRS Fire Radiative Power (FRP) product.

The Fire and Smoke Initiative was spurred by a request from the NWS for a satellite capability to improve smoke forecasts. VIIRS fire product developers began to meet with NWS fire experts and HRRR modelers to discuss the inclusion of the VIIRS Fire Radiative Power (FRP) into the HRRR Smoke Model. Once the initial work was completed, HRRR developers began running the upgraded smoke model over the Continental U.S. NWS personnel in the Western Region have provided feedback on how the HRRR smoke models was handling their largest wildfires. At the request of Alaskan forecaster's another HRRR region was opened up to handle the Alaskan interior. The monthly interaction helped identify other areas of collaboration. The successful demonstration of VIIRS fire products led the initiative to evaluate an array of products from other polar-orbiting and geostationary satellites including fire, aerosol and smoke.

WHO WE ARE

Established in 2014, the Fire and Smoke Initiative brings together subject matter experts who work to understand the current use of geostationary and polar orbiting satellite data to detect and forecast smoke and fire events. This Initiative provides a platform to establish methodologies and the procedures needed to demonstrate satellite derived fire and smoke products in operational user environments.

WHAT WE DO:

Members of this Initiative carry out ongoing dialogue with user communities to understand how VIIRS data and derived products can support their tasks and improve their situational awareness of wildfire events. Our members include representatives of government agencies such as NOAA, NASA, and the USFS, Cooperative Institutes, academic institutions, and other interested parties. We engage users such as the NWS and the USFS to determine how we can best support them with the VIIRS high spatial resolution and better sensitivity to smaller and hotter fires and assist in improved fire warnings/ detection and fire spread predictions. We look at how VIIRS, along with sensors such OMPS, and CrIS can support

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[1] Wayne E. Cascio, Wildland fire smoke and human health, 2018, Science of The Total Environment, 624, 586-595

improvements in warnings of poor air quality from fires, and from the emission of gases and particulate matter into the atmosphere. We put boots on the ground by getting researchers to the field to better understand our users' needs. We also connect users with developers to discuss and implement action plans to evaluate, evolve and update our products.

Focus Areas:

- Active fire location
- Fire radiative power, and
- Assimilation of satellite data to predict fire movement and dispersion of smoke using high spatial resolution and timely forecast models

WHO WE WORK WITH

Initially team members worked with the NWS and Air Quality personnel in response to wildfire events in in Alaska and the Western U.S. We have expanded our stakeholder engagement to include the National Interagency Fire Center (NIFC), the National Centers for Environmental Prediction (NCEP), NOAA Cooperative Institutes, the GOES-R Program, the National Park Service- AK, and the U.S. Forest Service.

WHEN WE MEET

We meet virtually throughout the year, at least once a month.

MAJOR ACCOMPLISHMENTS

Initiative teams successfully assimilated the JPSS Fire Radiative Power (FRP) product into NOAA's High-Resolution Rapid Refresh Model providing superb initial conditions for the model run.
Our teams utilized VIIRS imagery during the Fort McMurray fire in Alberta, Canada in May 2016, to help differentiate the fire line from the city lights of Fort McMurray. VIIRS Day/Night Band imagery showed the fire progression over consecutive nights and how the smoke was moving into the continental U.S. The team used its visualization products to show at what levels the smoke was present and its fire model to project the smoke's movement. These capabilities are now available for fire weather support personnel in Alaska and the NWS Western Region.

PROJECT(S):

Past efforts in the Fire and Smoke Initiative were tied to the operational use of the VIIRS Active Fire Product in the NWS Advanced Weather Interactive Processing System (AWIPS). Current projects in this initiative are researching how best to track smoke and aerosol movement from fires, identify where this smoke may stay aloft or stay close to the ground. The success of this work has led model developers to evaluate the GOES-R ABI FRP Product as a potential input to the HRRR model as well.

The following section presents summaries of our projects:

- **Rapidly updated high-resolution predictions of smoke, visibility and smoke-weather interactions using the VIIRS fire products within the Rapid Refresh and High-Resolution Rapid Refresh coupled with Smoke (RAP/HRRR-Smoke) modeling system**
- **Improving VIIRS Fire Radiative Power (FRP) Retrieval Using NUCAPS Carbon Monoxide (CO/CO2) for High Resolution Rapid Refresh (HRRR) Model Applications**
- **Web-based Tool for Rapid Burn Intensity Estimates Using VIIRS NDVI**
- **Improving user understanding and application of the Visible Infrared Imager Radiometer Suite (VIIRS) Active Fire (AF) products through capacity building and product evaluation**
- **Discrimination of flaming and smoldering biomass burning with VIIRS nighttime data**
- **Characterization and Application of JPSS Products in Biomass Burning Studies**

Rapidly updated high-resolution predictions of smoke, visibility and smoke-weather interactions using the VIIRS fire products within the Rapid Refresh and High-Resolution Rapid Refresh coupled with Smoke (RAP/HRRR-Smoke) modeling system

Ravan Ahmadov, Georg Grell, Curtis Alexander, Eric James, Ivan Csiszar, and Shobha Kondragunta

WHY IS THIS RESEARCH IMPORTANT?

Prescribed burnings and agriculture fires impact air quality, visibility and climate. Emissions from burning biomass have detrimental impacts on human health. They also cause reduced visibility which can disrupt ground and air transportation. The western part of the United States is especially prone to intense wildfires every year. The 2015 fire season shaped up to be one of the worst for the northwestern U.S. As reported by the U.S. Forest Service, https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd524898.pdf, more than a million acres were burned in state of Washington, and close to 130,000 tons of aerosols were emitted. Consequently, many parts of Pacific Northwest experienced unhealthy levels of air pollutants. Also in 2017, there were many large wildfires in the western US and Canada, which caused serious air quality problems in populated areas. California, for example, experienced one of its most devastating fire seasons in 2017.

GOAL: To utilize JPSS satellite data and NOAA's operational weather models (RAP and HRRR) to develop an experimental High-Resolution Rapid Refresh-Smoke (HRRR-Smoke) model that simulates the emissions and transport of smoke from wildfires and the impact of smoke on the weather.

RATIONALE: There are a number of regional air quality (AQ) forecasting models that include smoke from fires. However, there is still a need for high-resolution rapidly updated three dimensional AQ models that forecast smoke and related products that operational users such as NOAA's National Weather Service (NWS) and air quality agencies can use to alert the public.

OUTCOMES: Extended areal coverage (to cover all of North America), and increased forecast frequency (from the current 6 hourly update cycle to hourly updating) of the real-time modeling system currently in use.

Provide users with timely and more accurate smoke and additional derived forecast products such as smoke impact on surface visibility.

REFERENCES

Kaiser, J. W.; Heil, A.; Andreae, M. O.; Benedetti, A.; Chubarova, N.; Jones, L.; Morcrette, J. J.; Razinger, M.; Schultz, M. G.; Suttie, M.; van der Werf, G. R., Biomass burning emissions estimated with a global fire assimilation system based on observed fire radiative power. Biogeosciences 2012, 9, (1), 527-554.

Thompson, G. and T. Eidhammer (2014). "A Study of Aerosol Impacts on Clouds and Precipitation Development in a Large Winter Cyclone." Journal of the Atmospheric Sciences 71(10): 3636-3658.

James, E. P., and S. G. Benjamin, 2017: Observation System Experiments with the Hourly Updating Rapid Refresh Model Using GSI Hybrid Ensemble-Variational Data Assimilation. Mon. Wea. Rev., 145: 2897-2918. http://dx.doi.org/10.1175/MWR-D-16-0398.1

Freitas, S. R.; Longo, K. M.; Trentmann, J.; Latham, D., Technical Note: Sensitivity of 1-D smoke plume rise models to the inclusion of environmental wind drag. Atmos. Chem. Phys. 2010, 10, (2), 585-594.

Improving VIIRS Fire Radiative Power (FRP) Retrieval Using NUCAPS Carbon Monoxide (CO/CO_2) for High Resolution Rapid Refresh (HRRR) Model Applications

Shobha Kondragunta, Ivan Csiszar, and Ravan Ahmadov

WHY IS THIS RESEARCH IMPORTANT?

There is a grave need for accurate smoke forecasts for stakeholder consumption. These smoke forecasts are for events that happen naturally or due to human intervention but occur randomly and come with no advanced notice. Only satellite products that are operational and available near real time, when used in an intelligent way, can provide this service needed by end users. The most important of these end users are firefighters, forecasters, and the general public that rely on the forecasts and warnings to make life-altering decisions. These decisions can involve loss of life and property.

GOAL: To demonstrate that the FRP needs improvement by accounting for CO_2 absorption in atmospheric transmittance calculation in the FRP algorithm, use the improved FRP in the HRRR smoke forecast model, and work with the user community to discuss the benefits of improved smoke forecasts.

RATIONALE: The National Weather Service (NWS) uses numerical models such as HYSPLIT (Hybrid Single-Particle Lagrangian Integrated Trajectory), NGAC (NOAA Environmental Modeling System Global Forecasting System Aerosol Component) to provide smoke and aerosol forecast guidance respectively. Other experimental models such as High Resolution Rapid Refresh (HRRR) models are also used to provide smoke forecasts at much higher spatial resolution than the operational models. These numerical models that predict the location and transport of smoke rely on remotely sensed fire hot spots and emissions of trace gases and aerosols for input. These emissions in units of flux, ($Kg/m^2.s$) when ingested into the model, generate smoke that is then vertically and horizontally transported based on wind fields. The emissions of trace gases lead to the secondary formation of ozone and particulate matter in addition to primary particulates that are directly injected into the atmosphere. The accuracy of the model predicted smoke concentration is dependent on the accuracy of emissions.

OUTCOMES: Quality improvements of VIIRS fire products, and in particular the fire radiative power (FRP) which is used as input to derive emissions for the High Resolution Rapid Refresh (HRRR) smoke forecast model.

REFERENCES

Peter Fimrite & Kurtis Alexander, 17-year-old dies of burns, becomes 43rd victim of California wildfires, San Francisco Chronicle (October 30, 2017)

P. Olivia and W. Schroeder ATMOSPHERIC CORRECTION OF VIIRS AND MODIS FIRE RADIATIVE POWER RETRIEVALS FOR MULTI-SENSOR COMPARISON, IGARSS, 2015

A. Gambacorta, The NOAA Unique CrIS/ATMS Processing System (NUCAPS): Algorithm Theoretical Basis Document, 2013.

Web-based Tool for Rapid Burn Intensity Estimates Using VIIRS NDVI

Sam Batzli, Dave Parker, Nick Bearson, and Russ Dengel

WHY IS THIS RESEARCH IMPORTANT?

One mission of the Weather Forecasting Offices (WFOs) of the National Weather Service is to issue mudslide and debris flow warnings following wildland fires. Forecasters combine terrain, burn intensity, and meteorological information in a GIS (geographic information system) to identify and focus the attention of WFO staff and emergency managers on areas of potential risk. Burn intensity estimates created from Landsat satellite imagery are an essential piece of information that is used to support on-the-ground assessments of risk *when they are available.* However, the narrow swath and infrequent overpasses of Landsat make it unsuitable for debris flow forecasting. The VIIRS sensor on S-NPP and NOAA-20 with its wide swath and frequent overpasses is uniquely suited to greatly improve the applicability and timeliness of satellite-derived burn intensity estimates in this process.

GOAL: To work with a NWS-WFO end-user to design, build, and test a web-based dashboard for rapidly producing new VIIRS-derived post-fire Burn Intensity Delta Greenness Estimation (BRIDGE) maps to support mudslide and debris flow warnings.

RATIONALE: Currently, WFOs often have to wait for Burned Area Emergency Response (BAER) teams to complete on-the-ground assessments of flash flood and debris flow risk in order to know which areas are of concern. This knowledge is what enables WFOs to craft accurate warnings and support their emergency management and response partners. BAER teams utilize Landsat-derived Burned Area Reflectance Classification (BARC) products from the U.S. Forest Service or U.S. Geological Survey in their assessment process (Brown and Rowden 2014). However, this product is not intended to be used as an early warning tool, and it can arrive weeks too late for hazard-warning needs. However, researchers have discovered that a lower resolution but more expedient burn intensity estimate can be produced by calculating the difference between pre- and post-burn greenness products such as NDVI (Normalized Difference Vegetation Index) produced from VIIRS (Visible Infrared Imaging Radiometer Suite) satellite imagery (see figure). Past research (Pierce and Rowden 2015) has shown that the NDVI methodology has value, but it needs to be streamlined and automated to become routinely available to NWS-WFOs. A web-based tool will give NWS-WFOs a chance to generate timelier preliminary burn intensity estimates to utilize in their work with the emergency management and first responder community and with their forecast models, until more thorough assessments are completed. Reducing delays with VIIRS inputs and automation could save lives and property.

Figure: Difference between VIIRS NDVI on 20:43Z September 28, 2016 (pre-burn) and 20:41Z on September 26, 2017 (post-burn). Blue regions indicate reductions in NDVI following the Norse Peak Wildfire. Red lines outline areas of change. The VIIRS sensor, with its wide swath and frequent overpasses, is uniquely suited to greatly improve the applicability and timeliness of satellite-derived burn intensity estimates for debris flow forecasting.

OUTCOMES: 1) The streamlining and automated production of Burn Intensity Delta Greenness Estimation (BRIDGE) products derived from VIIRS satellite imagery; 2) development of a web-based dashboard to facilitate information access and control of the workflow; 3) support for debris flow forecast decision support services at NWS WFOs.

REFERENCES

Brown, Andrew and Katherine Rowden. "Adapting Services Provided to Meet the Needs of the Many Stakeholders Following Wildfires and the Eventual Flash Floods Near Wenatchee, WA." National Weather Service WFO, Spokane, WA. Poster presentation. 2014 American Meteorological Society Conference.

Pierce, Bradley and Katherine Rowden. "VIIRS Burn Scar Mapping - Potential New Remote Sensing Tool." Pilot Project Washington State, 2015. PowerPoint Presentation. 2017 US Forest Service BAER Conference.

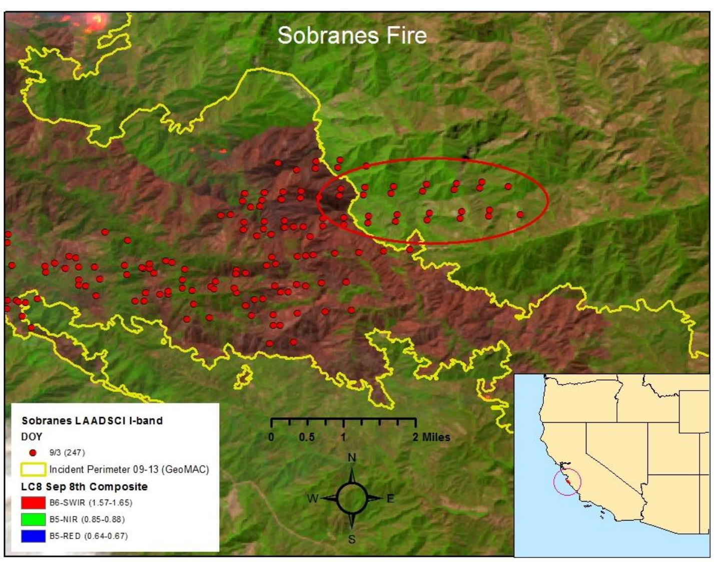
Improving user understanding and application of the Visible Infrared Imager Radiometer Suite (VIIRS) Active Fire (AF) products through capacity building and product evaluation

Evan Ellicott

WHY IS THIS RESEARCH IMPORTANT?

Timely and accurate data is necessary for both research and operations to develop improved models for wildfire prediction and near-real time situational awareness. NOAA plays a strategic role in wildfire monitoring and modeling with spaceborne assets developed to provide synoptic and timely data. The VIIRS AF and associated products such as the HRRR have been utilized in wildland fire fighting operations. These products provide situational awareness used at the national (NIFC), regional (WFO, GACC), and incident specific scale by meteorologists, fire behavior analysts, and intelligence personnel. The VIIRS AF product is critical to the smoke emissions and transport modelling (HRRR-smoke), particularly the FRP product. However, barriers exist, and they can impede data consumption. For example, locating the appropriate source (e.g. CLASS) for any given dataset and the process needed to obtain it is not universally known.

GOAL: To improve the VIIRS product through evaluation. This means working with end-users who identify issues with the active product. For example, the image below shows spurious detections, which are now under investigation. These may not have been identified if not for the project team members engaging with fire analysts working on incidents. The first path is improving VIIRS, and associated product information, through interactions with end-users and follow-up evaluation of the data. A second part of this goal is the creation of clearer metadata and uncertainty estimations in the detections - something end-users have been asking for.



False detections in the LAADSCI I-band from the Soberanes Fire in July 2016 in Monterey County on the California Central Coast

A second goal is to improve user knowledge of the active fire data. This involves capacity building - educating individuals and organizations who can themselves be trainers. This means education on where to get the data based on user needs and timeliness, insuring formats are user (e.g. GIS) friendly, explaining when the data is appropriate to use and when it may be uncertain (e.g. way off-nadir), which circles back to the first path - users want to know when they shouldn't trust what they are seeing.

RATIONALE: Locating the appropriate source (e.g. CLASS) to obtain the data and process is not universally known. Therefore, ensuring that the products and algorithms are utilized in operations is important that the end-user has knowledge of, and access to, the algorithms and products.

OUTCOMES: The inclusion of VIIRS in AWIPS II (CAVE), especially beyond the WFOs

A statistically driven, quantifiable estimate of uncertainty for every detection

Qualitative assessment of user-knowledge and product application. This will be conducted through surveys to be deployed first at the year-end fire meeting and then through the National Interagency Coordination Center (NICC). The NICC can disseminate the surveys to IMETs and FBANs, as well as geographic coordination centers (GACCs).

REFERENCES

Intergovernmental Panel on Climate Change. “Climate Change 2007: The Physical Science Basis.” Agenda 6, no. 07 (2007): 333.

Liu, Yongqiang, Scott Goodrick, and Warren Heilman. “Wildland Fire Emissions, Carbon, and Climate: Wildfire–climate Interactions.” Forest Ecology and Management 317 (April 2014): 80–96. doi:10.1016/j.foreco.2013.02.020.

Liu, Yongqiang, John Stanturf, and Scott Goodrick. “Trends in Global Wildfire Potential in a Changing Climate.” Forest Ecology and Management 259, no. 4 (February 2010): 685–97. doi:10.1016/j.foreco.2009.09.002.

Westerling, A. L. “Warming and Earlier Spring Increase Western U.S. Forest Wildfire Activity.” Science 313, no. 5789 (August 18, 2006): 940–43. doi:10.1126/science.1128834.

Discrimination of flaming and smoldering biomass burning with VIIRS nighttime data

Christopher D. Elvidge

WHY IS THIS RESEARCH IMPORTANT?

Biomass burning is one of the leading sources of greenhouse gas and smoke emissions worldwide. For decades, global satellite observations of biomass burning have been used to model fire emissions. The predominant form is the “hot spot” coming from instruments such as the NOAA Advanced Very High Spatial Resolution Radiometer (AVHRR), NASA Moderate Spatial Resolution Imaging Spectrometer (MODIS) and the Visible Infrared Imaging Radiometer Suite (VIIRS).

There are two distinct phases to biomass burning, flaming and smoldering. The phases differ radically from each other in terms of the composition of trace gas emissions and quantity of aerosol (smoke) missions. Ohlemiller (1995) defines smoldering as ‘a slow, low temperature form of combustion, sustained by the heat evolved when oxygen directly attacks the surface of a condensed-phase fuel’. Flaming is a higher temperature form of combustion, where an open air flame is fueled by gases released from temperature induced cracking of large chain polymer molecules present in biomass, such as cellulose and lignin (Lobert and Warnatz 1993). The two combustion phases also differ in terms of trace gas and particulate emissions related to the level of fuel oxidation, indexed as combustion efficiency -- i.e., high for the flaming phase and low for smoldering. Thus, distinguishing between the two is critically important for the modeling of atmospheric emissions.

GOAL: To develop a new VIIRS nightfire (VNF) product that derives temperatures and source areas for two combustion phases: flaming and smoldering for use in improved modeling of trace gas and aerosol emissions from biomass burning. The algorithm development will build upon the existing VNF code base, which assumes two components: a single hot source and single background. Modules will be added to VNF to enable detection and analysis of three components: flaming, smoldering and background.

RATIONALE: The two phases can be distinguished based on temperature, with flaming in the 800-1400 K range and smoldering near 400 K. Smoke generation from smoldering far exceeds that from the flaming phase, where combustion efficiency is higher. As standard satellite fire products are not designed to distinguish between the two combustion phases, adding combustion phase would be a revolutionary advance in the information content of satellite fire products.

OUTCOMES: A new style of satellite fire product containing information on flaming and smoldering phases for improved modeling of trace gas and aerosol emissions from biomass burning.

REFERENCES

Ohlemiller T J 1995 Smoldering combustion SFPE Handbook of Fire Protection Engineering Edited by MA Quincy, P J DiNenno, CL Beyler, R L P Custer and WD Walton, 2nd edn (Quincy, MA: National Fire Protection Association) section 2, chapter 11, pp 171–179.

Characterization and Application of JPSS Products in Biomass Burning Studies

Gregory Frost, Stuart McKeen, and Jonathan Guerrette

WHY IS THIS RESEARCH IMPORTANT?

Wildfires release large amounts of trace gases and aerosol emissions into the atmosphere. These emissions along with other pollutants can be transported by wind leading to harmful exposures for populations outside the vicinity of the wildfires.

As a result detailed measurements of trace gas and aerosol emissions from such biomass burning events, are important to helping understand their effects on climate, air quality and public health and also to inform actions and decisions about the atmosphere.

GOAL: To characterize JPSS trace gas and aerosol products and use them to improve the understanding of biomass burning sources of these atmospheric constituents.

RATIONALE: Observations from polar-orbiting satellites provide the input needed to monitor and understand the atmosphere, make predictions, and design mitigation and adaptation strategies (Goldberg et al., 2013). Polar-orbiting satellites such as the NOAA/NASA Suomi National Polar-orbiting Partnership (S-NPP) and the Joint Polar Satellite System (JPSS), including NOAA-20 and future satellite platforms in the series, will extend multi-decadal trace gas and aerosol data records from past and current polar orbiting instruments.

OUTCOMES: Demonstration of how JPSS trace gas and aerosol products add value to current and upcoming NOAA and NASA field studies aimed at quantifying atmospheric composition, air quality, and climate change.

Improved NOAA-Unique CrIS/ATMS Processing System (NUCAPS) trace gas and Visible Infrared Imaging Radiometer Suite (VIIRS) aerosol retrievals.

Improved operational forecasting capabilities with HRRR-Smoke.

REFERENCES

Barnard, J. C., et al., 2010: Technical Note: Evaluation of the WRF-Chem "Aerosol Chemical to Aerosol Optical Properties" Module using data from the MILAGRO campaign, Atmos. Chem. Phys., 10, doi:10.5194/acp-10-7325-2010.

Bousserez, N., Henze, D. K., 2017: Optimal and scalable methods to approximate the solutions of large-scale Bayesian problems: Theory and application to atmospheric inversion and data assimilation. Q.J.R. Meteorol. Soc., accepted. doi:10.1002/qj.3209.

Fu, J. S., et al., 2012: Evaluating the influences of biomass burning during 2006 BASE-ASIA: regional chemical transport modeling. Atmos. Chem. Phys., 12, doi:10.5194/acp12-3837-2012.

Gambacorta, A., et al., 2014: An experiment using high spectral resolution CrIS measurements for atmospheric trace gases: Carbon monoxide retrieval impact study. IEEE Geosci. Remote Sens. Lett., 11, doi:10.1109/LGRS.2014.230364.

Goldberg, M. D., et al., 2013: Joint Polar Satellite System: The United States next generation civilian polar-orbiting environmental satellite system. *J. Geophys. Res.*, 118, doi:10.1002/JD020389.

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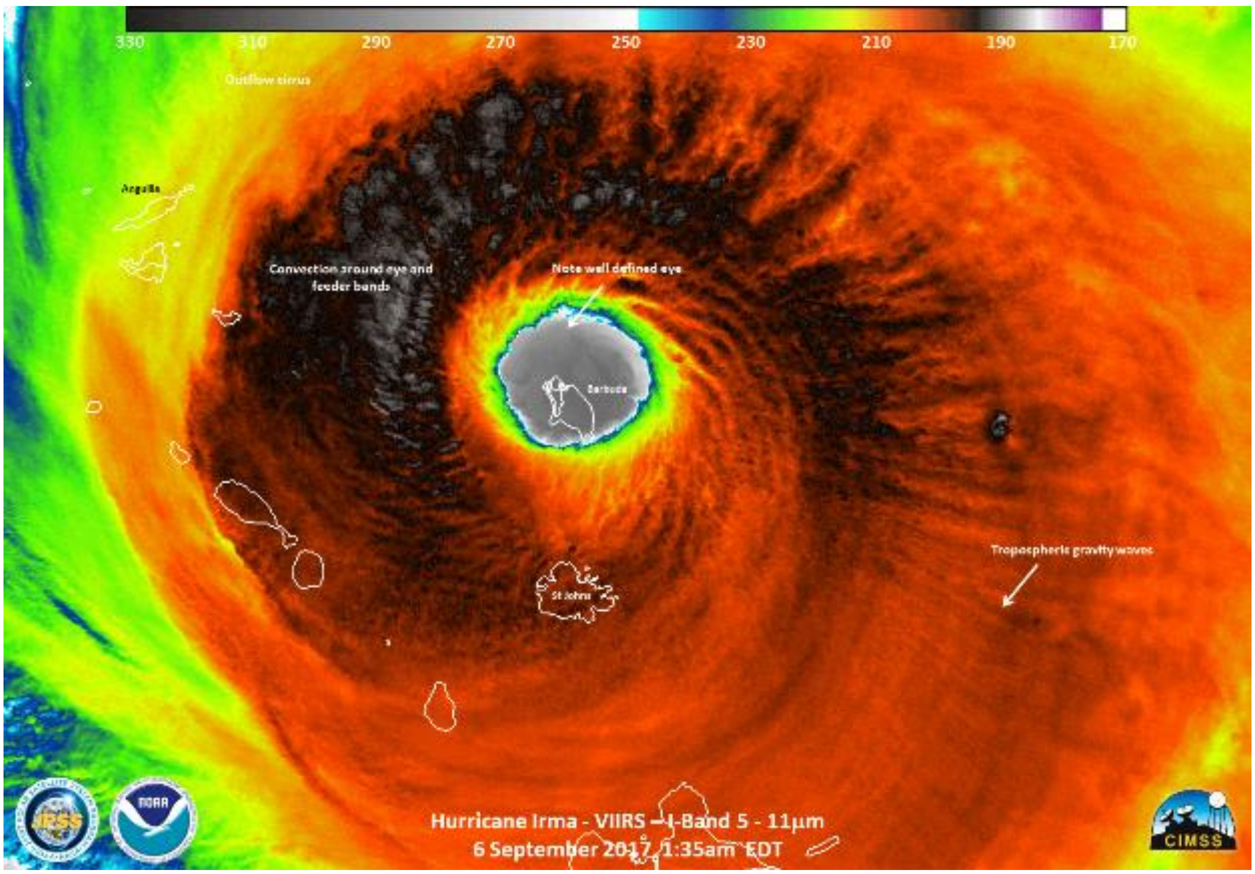
HURRICANES AND TROPICAL STORMS INITIATIVE



Infrared image from VIIRS of hurricane Irma as she hits the Island of Barbuda. Credit NOAA/JPSS

MOTIVATION:

According to NOAA's National Centers for Environmental Information (NCEI) during 2017, the U.S. experienced a historic year of weather and climate disasters. In total, the U.S. was impacted by 16 separate billion-dollar disaster events including: three tropical cyclones, eight severe storms, two inland floods, a crop freeze, drought and wildfire. The damage from Hurricanes Harvey, Irma and Maria alone are responsible for approximately $265 billion of the $306 billion total loss in 2017. Each of these destructive hurricanes now joins Katrina (2005) and Sandy (2012), in the new top-five costliest U.S. hurricanes on record.

The National Hurricane Center (NHC) in Miami, FL has tropical cyclone (TC) forecast and warning responsibilities for the Atlantic and eastern North Pacific to 140°W. The Central Pacific Hurricane Center (CPHC) in Honolulu, HI has these same responsibilities from 140°W to the dateline. The Joint Typhoon Warning Center (JTWC), also in Honolulu, has TC forecast responsibilities for the U.S. Department of Defense (DoD) interests for all other tropical cyclone basins, including the Western North Pacific, Indian Ocean and Southern Hemisphere. Satellite remote sensing is a fundamental tool for TC analysis and forecasting at all three U.S. TC forecast centers. Satellite data and products are used directly by forecasters for TC analysis and situational awareness and used indirectly through their inclusion in statistical and dynamical forecast models.

NHC routinely verifies its track and intensity forecasts at the end of each hurricane season. Results show that the track forecasts have improved dramatically over the past few decades (https://www.nhc.noaa.gov/verification/). For example, the average five-day track error of the NHC official forecasts for the Atlantic in 2017 was smaller than the average 48 hour track error in the 1990s and smaller than the 36 hour average track error in the 1980s. These forecast error reductions were primarily due to the large improvements in dynamical track forecast models. The NHC official intensity errors improved very slowly over most of this same time period, but improved at a faster rate in the past five years or so. The recent intensity forecast error reduction was due to improvements in dynamical and statistical models.

Despite the forecast improvements described above, significant challenges remain. As part of the Joint Hurricane Testbed (JHT, https://www.nhc.noaa.gov/jht/), the three TC forecast centers provide bi-annual updates to operational research priorities to guide the selection of new projects. Common themes in those priorities include improved methods for tropical cyclone center location and intensity and wind structure analysis, improved intensity prediction, especially for rapidly intensifying and weakening TCs, and exploitation of microwave satellite data. The JPSS TC initiative is well-aligned with these operational priorities of the U.S. forecast and warning centers.

WHO WE ARE

This initiative is comprised of a research and development team from universities and federal agencies with long histories of successful development and operational transition of TC forecast algorithms, including the Naval Research Laboratory, Monterey (NRLMRY), the University of Wisconsin Cooperative

Institute for Meteorological Satellite Studies (UW/CIMSS), the Colorado State University Cooperative Institute for Research in the Atmosphere (CSU/CIRA) and the NOAA/NESDIS Center for Satellite Applications and Research (NESDIS/STAR). This research team will work closely with operational users from the three operational TC forecast centers (NHC, CPHC, JTWC) to develop new or improved analysis and forecast methods and to obtain feedback on real-time demonstrations. The initiative coordinator is Monica Bozeman, a member of the NHC Technology and Science Branch.

WHAT WE DO:

This initiative focuses on improving the use of JPSS data by forecasters at NWS' NHC and CPHC and the DoD JTWC. Satellite data and products are used by NHC, CPHC and JTWC forecasters for TC analysis, situational awareness and forecasting. This usage will be enhanced by development of new and improved methods for TC center location, intensity and size estimation, and statistical intensity forecast models. As mentioned above, all of these applications have been identified as high priorities by the operational forecast centers. This initiative also includes improving acquisition of JPSS data and displays on NHC's operational platforms such as AWIPS. The projects selected for funding are parts of one overarching plan to meet the objectives stated above. It is expected that some of the applications developed through this initiative will be transitioned to operations following the completion of the projects using mechanisms such as the JHT.

Focus Areas:

Tropical Cyclone Monitoring with VIIRS– VIIRS imagery, especially the DNB, is useful for storm center estimation, storm structure and cloud analysis. However imagery latency can hinder NHC forecaster use and needs to be addressed. Improved data ingest and display systems will be developed to increase forecaster usage.

Storm Analysis with Microwave (MW) Imagery – There is a need to improve upon those capabilities that use MW imagery from multiple platforms (SSMI, SSMIS, GPM GMI, GCOM-W1, AMSR2, ATMS, AMSU and Windsat) to help NHC forecasters analyze inner core structure, including center finding, convective organization, and eyewall formation and replacement cycles.

Quantitative Products from ATMS and CrIS Sounders – This task focuses on improving TC intensity and wind structure estimation algorithms using sounder data. This task also includes improving the retrievals used for the diagnostics. Diagnostics from sounder data include moisture flux calculated from MW retrievals and global model wind fields in the near TC environment, center location and eyewall structure analysis.

Improvements to Statistical Tropical Cyclone Intensity Forecast Models – Because of the difficulty of TC intensity forecasting, NHC still relies on statistical intensity models to complement dynamical hurricane models. Operational models include the Statistical Hurricane Intensity Prediction Scheme (SHIPS), the Logistic Growth Equation Model (LGEM) and the Rapid Intensification Index (RII). This task focuses on improving these statistical models using new predictors from imager and sounder data. Candidate predictors include moisture flux products, parameters derived from layered precipitable water products, eye detection algorithms that also utilize VIIRS and geostationary data, and convective structure variables from MW imagery.

Microwave imagery processing system –Previous studies showed that predictors from MW imagers can improve NHC's statistical intensity models. However, none of these methods were transitioned to operations due to the lack of a MW data normalization and processing system. This system is needed to produce the large historical datasets for training statistical algorithms and to run in NHC's operational computing environment for real-time forecasting.

WHO WE WORK WITH

The development team will work closely with other research groups at their host institutions and operational partners at NHC, CPHC and JTWC. The latter coordination will include operational forecasters for product feedback, and infrastructure groups such as NHC's Technology and Science Branch (TSB) to use operational display systems when possible. The team will also work with NOAA agencies involved in TC application development, including NESDIS/STAR and the NOAA/OAR Hurricane Research Division.

WHEN WE MEET

The development team will meet monthly to track project milestones and identify issues that may require assistance from JPSS-PGRR management. Those meetings will be led by the initiative coordinator, Monica Bozeman.

Quarterly meetings will also be held with a wider group that includes operational partners and JPSS management staff to provide progress reports, guidance on real-time demonstrations and user feedback.

MAJOR ACCOMPLISHMENTS

This project is in its early stages so there are no major accomplishments to report

PROJECT(S):

The following section presents summaries of our projects:

- **Implementation of a data ingest, standardization, and output system.**
- **Serving forecasters with advanced satellite-based TC center-fixing and intensity information.**
- **Improving Tropical Cyclone Forecast Capabilities Using the JPSS data Suite**

Implementation of a data ingest, standardization, and output system.

Josh Cossuth, and Mindy Surratt

WHY IS THIS RESEARCH IMPORTANT?

An important part of using JPSS data for TC analysis and forecasting at operational forecast centers is the availability of a real-time processing system, and the generation of large normalized datasets for algorithm training. Transition of statistical intensity models to NHC operations has been hindered in the past by the lack of this system. This research will mitigate that limitation and provide an infrastructure for other algorithms developed in this initiative with a path to operations.

GOAL: To enhance the capability of TC forecasters to receive timely, added value JPSS data and products in their forecasting environment.

RATIONALE: Currently, forecasters do not have access to processed, TC-centric microwave data and products in their operational environment.

OUTCOMES: Adaptation of the NRL's Geolocated Information Processing System (GeoIPS) at operational centers such as the NHC, CPHC and JTWC. The GeoIPS is an in-house software, which facilitates access to microwave data and products, expedites latency through direct readout of JPSS constellation information, standardizes processing of polar orbiting datasets, and delivers storm-centric analyses in near-real-time directly to forecasters to help with center finding, intensity analysis, and structure tendency (including convective organization and eye formation/replacement).

REFERENCES

Hawkins, J. D., T. F. Lee, F. J. Turk, C. Sampson, J. Kent, and K. Richardson, 2001: Real–Time Internet Distribution of Satellite Products for Tropical Cyclone Reconnaissance. Bull. Amer. Meteor. Soc., 82, 567–578

Wimmers, A. J., and C. S. Velden, 2016: Advancements in objective multisatellite tropical cyclone center fixing. J. Appl. Meteor. Climatol., 55, 197–212.

Yang, S., J. Hawkins, and K. Richardson, 2014: The Improved NRL Tropical Cyclone Monitoring System with a Unified Microwave Brightness Temperature Recalibration Scheme. Remote Sens., 6, 4563-4581.

Halperin, D. J., H. E. Fuelberg, R. E. Hart, and J. H. Cossuth, 2017: The development and evaluation of a statistical-dynamical tropical cyclone genesis guidance tool. Wea. Forecasting, 32, 27–46

Serving forecasters with advanced satellite-based TC center-fixing and intensity information.

Anthony Wimmers, Derrick Herndon, and Chris Velden

WHY IS THIS RESEARCH IMPORTANT?

Computational methods to analyze tropical cyclone (TC) characteristics from microwave satellite imagery have become more advanced and necessary for forecasting, but problems inherent in transitioning these algorithms to operations have actually become more acute. If the problem continues unresolved, it will hinder the operational usage of many TC analysis algorithms that rely on JPSS data.

GOAL: to integrate root-level TC analysis algorithms from CIMSS into the GeoIPS platform and optimize these algorithms for JPSS. Quantitative TC forecasting depends on the availability of root-level algorithms, such as center-fixing and intensity nowcasting within the data processing environment, because other techniques rely on these algorithms in order to function.

RATIONALE: Satellite imagery of TCs serves a vital purpose not just as a visual confirmation of a forecast, but also for providing quantitative information that directly leads to actionable outcomes, such as by revealing intensity, rapid intensification, TC structure and path. While research techniques using microwave sensors onboard polar-orbiting satellites have shown increasing skill at addressing these topics, the problems inherent in transitioning these techniques from research to operations (R2O) for centers such as NHC and CPHC have become more acute. This is because many of their primary tools are designed around the presentation of incoming data in a fixed-coordinate environment rather than a more challenging TC-centered framework using sectionalized (cropped) data. Most research groups have addressed this issue by developing their own ad-hoc TC-centered data ingesting platforms, but the operational usage of many TC analysis algorithms is hindered as these platforms are not adequate to be adapted to operations. As a result, many operations-ready TC satellite data analysis algorithms remain anchored to their local data processing environment without a clear path to operations.

OUTCOMES: The adoption of many JPSS derived TC analysis algorithms and products in operations at national centers such as the NHC and CPHC.

REFERENCES

DeMaria, M., C. Sampson, J. Knaff and K. Musgrave, 2014: Is tropical cyclone intensity guidance improving? Bull. Amer. Meteo. Soc., 95, 387-398

Kossin J.P and M. DeMaria, 2016: Reducing operational hurricane intensity forecast errors during eyewall replacement cycles. Wea. Forecasting, 31, 601-608

Rozoff, C. M., C. S. Velden, J. Kaplan, J. P. Kossin, and A. J. Wimmers, 2015: Improvements in the probabilistic prediction of tropical cyclone rapid intensification with passive microwave observations. Wea. Forecasting, 30, 1016-1038, 2015.

Wimmers, A. J. and C. S. Velden, 2016: Advancements in objective multisatellite tropical cyclone center fixing, J. Appl. Meteor., 55, 197-212.

Improving Tropical Cyclone Forecast Capabilities Using the JPSS data Suite

Galina Chirokova and Dr. John Knaff

WHY IS THIS RESEARCH IMPORTANT?

Intensity forecasts have improved slowly compared to track forecasts in the last few decades (DeMaria et al. 2014), and forecasting rapid intensification (RI), remains an especially challenging and important problem - one of the highest priorities within NOAA. Because of the difficulty of RI forecasting, operational TC centers still rely heavily on statistical algorithms as guidance (Kaplan et al 2014). JPSS data is well suited for diagnosing the thermodynamic structure in the near-storm environment. Predictors from those retrievals have considerable potential to improve statistical intensity forecast and RI models. Both Suomi NPP (launched in October, 2011) and NOAA-20 (launched in November, 2017) carry the same instrument suite so that all Suomi NPP applications can be extended to NOAA-20, which will more than double the amount of JPSS data available for model training. The research will also improve the use of JPSS data for tropical cyclone analysis, providing a more accurate starting point for track, intensity and structure forecasting.

GOAL: To improve operational TC position, intensity, and wind structure estimates, as well as intensity forecasts, including rapid intensity changes, using JPSS data.

RATIONALE: The time scale of TC track and intensity changes is on the order of 6-12 hours, which makes JPSS instruments well suited for the TC analysis and forecasting. JPSS S-NPP and NOAA-20 data from ATMS and VIIRS provide a large amount of unique information that could be critical for improving TC track and intensity forecasts and is currently underutilized. Unique JPSS data and products include very accurate temperature and moisture profiles in the TC environment and DNB imagery. CIRA developed several JPSS TC applications that are currently running in real-time for NHC, CPHC and JTWC, including the Hurricane Intensity and Structure Algorithm (HISA) (Demuth et al 2006), TC-centered DNB imagery (TC-DNB), and the proxy-visible nighttime imagery (PVNI)]. Several other algorithms show promise, including the satellite eye-detection routine (SEDR), and the Moisture In-Flux Storm Tool (MIST), which provides unique information about dry-air intrusions. The existing applications will be improved and expanded and new applications developed using both Suomi NPP and NOAA-20 data.

OUTCOMES: The enhanced and newly developed applications have the potential to lead to improved TC position, intensity, and structure estimates, as well as improved intensity forecasts. Once developed and tested, the new products will be made available via the satellite Proving Ground to operational forecasters at NHC, CPHC, JTWC for evaluation and feedback. Following a positive evaluation, the products can then be considered for transitioning to operations, using programs such as the JHT.

REFERENCES

Demuth, J.L., M. DeMaria and J.A. Knaff, 2006: Improvement of the Advanced Microwave Sounding Unit tropical cyclone intensity and size estimation algorithms. Mon. Wea. Rev., 45, 1573-1581.

DeMaria, M., C.R. Sampson, J.A.Knaff and K.D. Musgrave, 2014: Is tropical cyclone intensity guidance improving? Bull. Amer. Meteor. Soc., 95, 387-398.

Kaplan, J., and co-authors, 2015. Evaluation environmental impacts on tropical cyclone rapid intensification predictability utilizing statistical models. Wea. Forecasting, 30, 1374-1396.

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Wimmers, Tony	UW/CIMSS
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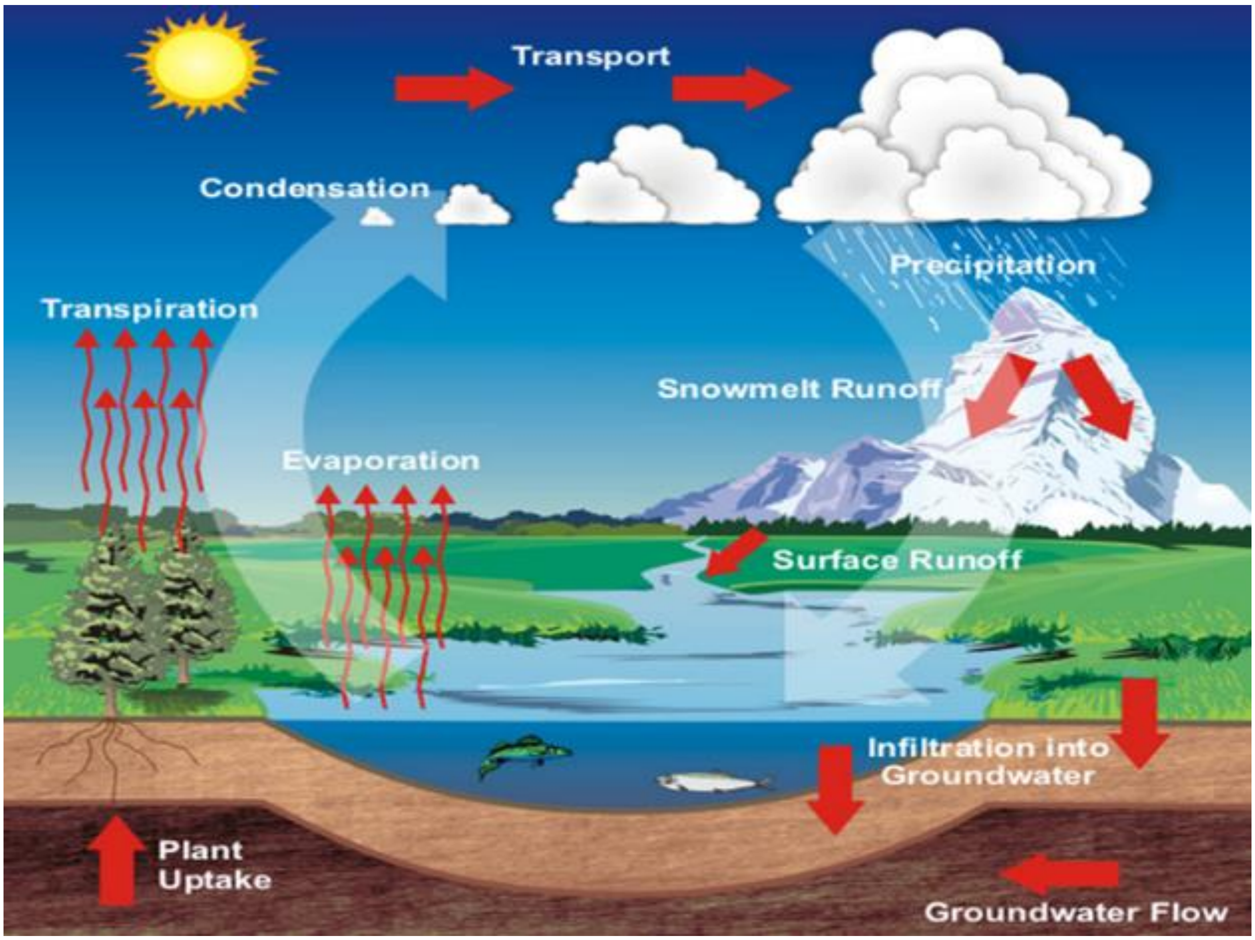
HYDROLOGY INITIATIVE



MOTIVATION:

Precipitation is a crucial link in the hydrologic cycle, and its large spatial and temporal variations are drivers for regional hydrology and global freshwater balance. Accurate knowledge of the timing and spatial distributions and amount of regional rainfall is essential to make accurate, short-term forecasts to provide safety to the general public. Rainfall also drives the hydrological cycle, and to improve weather and climate predictions, an accurate global coverage of rainfall records is necessary. Also important are other aspects of the hydrological cycle - soil moisture and precipitable water (total, critical layers).

WHO WE ARE:

The Hydrology Initiative consists of NOAA and academic partner principal investigators, together with NESDIS operational product teams, end users from the National Weather Service (including national centers such as the Weather Prediction Center and National Water Center; forecast offices) and other interested groups, who strive to exploit JPSS satellite data and products to improve our understanding and prediction of water related forecasting challenges.

WHAT WE DO:

Projects were solicited to include use of Suomi NPP, NOAA-20 and Global Change Observation Mission (GCOM) AMSR2 precipitation (e.g., rain rate, etc.), soil moisture, snow water equivalent, and precipitable water products. To improve NOAA precipitation and related hydrological applications, studies can consider blending existing JPSS products with other sensor data. These includes Defense Meteorological Satellite Program (DMSP) Special Sensor Microwave Imager/Sounder (SSMIS), MetOp Advanced microwave sounding unit (AMSU)/ Microwave Humidity Sounder (MHS), Global Precipitation Measurement (GPM) Microwave Imager (GMI) and Dual-frequency Precipitation Radar (DPR), or other data sources. Projects that would benefit NWS Office of Water Prediction, including the National Water Center, as well as RFCs, are encouraged.

Focus Areas:

1. Improvement of Hydrology EDR's - precipitation (rain and snow rate), soil moisture, snow water equivalent and precipitable water.
2. Multi-sensor /fusion approach for better temporal coverage. Includes synergistic use of VIIRS with ATMS, AMSR-2 and GOES-16 (ABI, Geostationary Lightning Mapper (GLM)) to improve rainfall and snowfall retrieval
3. Regional algorithm development and application to exploit direct broadcast data improvements to precipitation retrievals under conditions of orographic forcing, where conventional retrieval algorithms are known to break down.
4. Exploitation of JPSS satellite products to improve or validate the NWS National Water Model.

WHO WE WORK WITH

We work closely with NWS National Centers and forecast offices to determine the utility of JPSS baseline and emerging (PGRR) products. We also engage with other initiatives like NUCAPS, River and Ice Flooding and the Arctic.

WHEN WE MEET

The Hydrology Initiative meets approximately four times per year as a main group, however, several specialized “tiger teams” meet more frequently as new areas of collaboration are identified and require more frequent interaction.

MAJOR ACCOMPLISHMENTS

During the past year, the Hydrology Initiative was able to accomplish the following:

- The snowfall rate product became a JPSS requirement, thus, long term maintenance funding was secured to monitor and develop a NOAA-20 SFR product
- Developed a maturing relationship with the National Water Center (as part of the NOAA Water Initiative), with a new PGRR project being funded to compare satellite soil moisture with similar parameters used within the NOAA Water Model. This project is captured in the NOAA Water AOP for FY19.
- Participated in the 2018 Arctic Summit and developed maturing relationships with the NWS forecast and river forecast offices in Alaska
- Funded a brand new project to incorporate the advection scheme from the MIMIC water vapor product into the operational blended TPW product.

PROJECT(S):

The following section presents summaries of our projects:

- **Merged Water Vapor Products for Forecasters using Advanced Visualization Methods**
- **Ensemble flood forecasting system coupling WRF-Hydro with Satellite Data (JPSS and GOES-R) for Puerto Rico**
- **Development of Snowfall Rate over Ocean, Sea Ice, and Coast Product to Support Weather Forecasting**
- **Improving and Reprocessing the CMORPH Satellite Precipitation Estimates and Global OLR Analysis with Retrievals from JPSS**
- **Improving JPSS Soil Moisture Data Products for Use in Evaluation and Benchmarking of the National Water Model**

Merged Water Vapor Products for Forecasters using Advanced Visualization Methods

John M. Forsythe, Anthony Wimmers, Andrew S. Jones, Stanley Q. Kidder, Dan Bikos, Sheldon Kusselson, and Christopher Velden

WHY IS THIS RESEARCH IMPORTANT?

Forecasters have used multisensor blended total precipitable water (TPW) products operationally since 2009. These products have a multitude of uses for weather forecasting. By blending many separate spacecraft scans into one product, forecasters can track the water vapor plumes that fuel heavy precipitation events. These products are observationally-driven with minimal model dependence and thus provide forecasters with situational awareness independent of forecast models.

Experimental products that advectively blend satellite water vapor retrievals from microwave sensors aboard polar orbiting satellites have become increasingly popular with NWS forecasters. Advective blending offers a drastic reduction to the visual limitations seen with traditional LPW imagery, as satellite swath lines and data discontinuities are largely removed.

GOAL: To combine CIRA and CIMSS capabilities to develop a new advected TPW product, which is ready for a straightforward transition to NOAA operations.

RATIONALE: To date, blended TPW delivered operationally to forecasters has not benefited from advances in "advective blending." Advectively blended TPW was first demonstrated by Wimmers and Velden (2011), and fuses microwave satellite water vapor retrievals (NOAA MiRS system, Boukabara et al. 2011) with GFS winds to allow a seamless visualization of the flow of moisture in the atmosphere. This technique minimizes jumps and data stalling which would otherwise occur due to the irregular temporal sampling of the polar orbiting spacecraft used to retrieve TPW. The result is a more physically realistic visualization of the flow of water vapor in the atmosphere. However, advection is currently not used in the operational blended TPW product. CIRA developed an Advected Layer Precipitable Water (ALPW) product, which is similar to advectively blended TPW, but the atmosphere is partitioned into four layers to provide forecasters a view of moisture transport in the vertical.

While there is wide use of these products in many NWS regions; forecasters have noted a desire for a consolidated product that features the best properties of each of them. Such a product would gain a lot more traction in NWS regions and would most likely be on a faster track to operational implementation.

OUTCOMES: User-vetted, next-generation TPW and ALPW products running in the same CIRA processing system which is operational at NOAA, with a low effort required to transition to operations.

REFERENCES

Forsythe, J. M., S. Q. Kidder, K. K. Fuell, A. LeRoy, G. J. Jedlovec, and A. S. Jones, 2015: A multisensor, blended, layered water vapor product for weather analysis and forecasting. J. Operational Meteor., 3 (5), 41-58, doi:http://dx.doi.org/10.15191/nwajom.2015.0305.

Wimmers, A. J., and C. S. Velden, 2011: Seamless advective blending of total precipitable water retrievals from polar-orbiting satellites. J. Appl. Meteor. Climatol., 50, 1024–1036.

Ensemble flood forecasting system coupling WRF-Hydro with Satellite Data (JPSS and GOES-R) for Puerto Rico

Tarendra Lakhankar, and Jonathan Muñoz-Barreto

WHY IS THIS RESEARCH IMPORTANT?

Puerto Rico in past decades has been plagued with constant floods, whose impact range from limited to catastrophic. In fact, some of the largest unit discharge flood peaks in the stream gaging records of the U.S. Geological Survey (USGS) have occurred in Puerto Rico (Smith et al., 2005). This can be attributed to the weather patterns of a tropical climate, where constant high temperatures lead to high intensity convective rainfall. Even though any rainfall event can lead to a flood, they are more likely to occur during the hurricane season.

Currently, the Flash Flood Guidance method is used for flash flood analysis in Puerto Rico. The Guidance divides the territory in 13 areas and provides a single value for each one of them. This process determines the average precipitation required over a given area and its duration to cause flooding on a stream (Southeast RFC, 2017).

Puerto Rico's topography and weather patterns can change drastically in short distances, thus the guidance value may not be an accurate representation for the geographic domain contained within each of the 13 subdivisions. More importantly, while these methods allow local meteorologists some limited confidence in issuing watches and warnings for the HSA, the SERFC staff and the WFO San Juan Service Hydrologist are constantly looking for ways to improve and spatially expand hydrologic operations for the entire region.

GOAL: Explore the use of the Weather and Research Forecasting Hydrological modeling system (WRF-Hydro) in simulating several major flood events caused by heavy rainfall in Puerto Rico.

RATIONALE: As the models used currently fail to account for variations in topography and weather patterns across short distances, an alternative sampling method that considers these differences and would facilitate hydrological calculations at a more representative spatial scale would improve various applications including flash flood operations.

OUTCOMES: To have an ensemble flood forecasting system coupling WRF-Hydro with satellite data (JPSS soil moisture product and GOES-R precipitation product) and NOAA numerical weather and climate models for Puerto Rico.

REFERENCES

Olivieri J.N., Muñoz-Barreto J., Tirado-Corbalá R., Lakhankar T., and A Fisher (2017) Comparison and downscale of AMSR2 soil moisture products with in-situ measurements from the SCAN-NRCS network over Puerto Rico, Hydrology, 4(4), 46; doi:10.3390/hydrology4040046.

Development of Snowfall Rate over Ocean, Sea Ice, and Coast Product to Support Weather Forecasting

Huan Meng

WHY IS THIS RESEARCH IMPORTANT?

Snowfall is a major form of precipitation in the high latitudes and mountain regions. Given limited coverage from, or a sparsity of, surface-based observing systems, the NOAA National Weather Service (NWS) requirements for snowfall observations in these regions cannot be fully met. Satellites can provide much needed winter weather information in these regions owing to broad coverage. A set of SFR products has been developed for passive microwave sensors including the ATMS instrument onboard the Suomi NPP satellite.

While user feedback indicates the usefulness of the land SFR product to weather forecasting and hydrological applications, there are also growing needs for SFR over ocean, sea ice, and coast for National Weather Service (NWS) forecast offices and national centers. Developing an ocean algorithm will be of particular benefit to coastal communities, by providing information on snowstorms offshore before they transition to land, or on spiraling snow bands from offshore that can reach land.

GOAL: The expansion of SFR over the ocean to include open water, sea ice and coast, and extension of the Suomi NPP based ATMS SFR algorithm to NOAA-20.

RATIONALE: The existing land SFR algorithm is not applicable over ocean as land and ocean provide very different radiative background to passive microwave measurements at window channels which are sensitive to the surface. Thus an algorithm that is sensitive to the radiative background provided by the ocean is needed. But more than this, the different environmental conditions over ocean and over land also produce distinctively different snowfall modes. While deep snowfall prevails over land, shallow snowfall dominates over ocean. As a result, the unique characteristics of oceanic snowfall also have to be taken into account.

OUTCOMES: Expansion of the ATMS SFR to cover a wider range of geographic areas and applications that will aid coastal NWS forecast offices as well as Alaska.

REFERENCES

Kongoli, C., H. Meng, J. Dong, and R. Ferraro 2015: A snowfall detection algorithm over land utilizing high-frequency passive microwave measurements—Application to ATMS, J. Geophys. Res. Atmos., 120, 1918–1932, doi:10.1002/2014JD022427.

Kongoli, C., H. Meng, J. Dong, and R. Ferraro, 2018: A Hybrid snowfall detection method from satellite passive microwave measurements and global forecast weather models, Quarterly Journal of the Royal Meteorological Society, DOI:10.2002/qj3270.

Meng, H., J., Dong, R., Ferraro, B., Yan, L., Zhao, C., Kongoli, N.-Y., Wang, and B., Zavodsky, 2017: A 1DVAR-based snowfall rate retrieval algorithm for passive microwave radiometers, J. Geophys. Res. Atmos., 122, doi:10.1002/2016JD026325.

Improving and Reprocessing the CMORPH Satellite Precipitation Estimates and Global OLR Analysis with Retrievals from JPSS

Pingping Xie, and Robert J. Joyce

WHY IS THIS RESEARCH IMPORTANT?

Precipitation and outgoing longwave radiation (OLR), together with sea surface temperature (SST), are the three most important geophysical variables reflecting the state and variations of global climate (Higgins 2013). Operational monitoring and forecasting of global and regional climate relies heavily on the real-time updates of precipitation and OLR data sets of high time/space resolution with reasonable quantitative accuracy. Long-term temporal consistency is a basic requirement to ensure that current state of the Earth system may be evaluated from a climate perspective For example, monitoring of MJO and associated hazards requires quantitative examination of precipitation and OLR anomalies on a real-time basis at a relatively high time/space resolution. Precipitation and radiation forcing used to drive land surface models need to be homogenous throughout the entire period to ensure climate and hydro-climate applications.

GOAL: To create global and regional satellite precipitation estimates with the Climate Prediction Center (CPC) Morphing technique (CMORPH) and to construct blended hyperspectral OLR data sets for improved operational climate and hydroclimate applications.

RATIONALE: The current version of CMORPH (and other blended rainfall products) are generally confined to latitudes equatorward of 60 degrees latitude. This is generally due to the poor relationship to satellite retrievals under cold season regimes. By exploiting the JPSS SFR product, CMOPRH can be expanded to a near global product. Additionally, the long standing OLR time series can be expanded into the JPSS era.

OUTCOMES: Reprocessed high-quality, high-resolution JPSS infused CMORPH pole-to-pole global satellite precipitation estimates with explicit representation of snowfall rate for the JPSS era; regional CMORPH running operationally to produce high-resolution precipitation estimates with improved quality, refined time/space resolution and reduced latency; and a blended global OLR data set from 1979 to replace the current operational AVHRR OLR. Both data sets will be updated on a quasi real-time basis.

REFERENCES

Joyce, R.J., and P. Xie, 2011: Kalman Filter Based CMORPH, J. Hydrometeor., 12, 1547 – 1563, DOI: 10.1175/JHM-D-11-022.1.

Xie, P., R. Joyce, S. Wu, S.-H. Yoo, Y. Yarosh, F. Sun, and R. Lin, 2017a: Reprocessed, bias-corrected CMORPH global high-resolution precipitation estimates. J. Hydrometeor., 18, DOI: http://dx.doi.org/10.1175/JHM-D-16-0168.1.

Improving JPSS Soil Moisture Data Products for Use in Evaluation and Benchmarking of the National Water Model

Xiwu Zhan, Nai-Yu Wang, Jifu Yin, and Jicheng Liu

WHY IS THIS RESEARCH IMPORTANT?

Water resources stakeholders across the United States have revealed the need for consistent, high space- and time-resolution, integrated water analyses, predictions, and data to address critical unmet information and service gaps related to floods, droughts, water quality, water availability, and climate change. To meet these growing stakeholder demands and needs, NOAA has undertaken a major effort to improve its hydrological forecast services through the development of a new National Water Model (NWM) at the National Water Center (NWC). The NWM simulates and forecasts land surface runoffs and river discharges using model estimated land surface soil moisture via response to the forcing (precipitation and others). Currently NWM does not use any external soil moisture data. Because of the uncertainties in model physics and input parameters, and potential errors in forcing data such as precipitation, the soil moisture estimates may be erroneous, resulting uncertainties in the output of the NWM.

GOAL: To assess how the JPSS satellite hydrological data sets can help evaluate and improve NWM in NWC's Enterprise Evaluation System, and to comprehensively evaluate the existing JPSS satellite soil moisture data products, identify the data need specifics of the NWM, and further improve the JPSS hydrological data products to meet the specific needs.

RATIONALE: Because of the uncertainties in model physics, input parameters, and forcing data such as precipitation, land surface model soil moisture simulations could be erroneous, or contain large uncertainties (Reichle and Koster 2004; Peters-Lidard et al. 2008). These errors or uncertainties may exist in the Noah-MP simulations used by the NWM. One way to reduce the soil moisture simulation uncertainties is to use satellite observations such as the JPSS soil moisture product. JPSS-supported microwave and optical satellite sensors (i.e. AMSR2 and VIIRS) have been providing observational soil moisture and other hydrological data products for NOAA operations. These data sets have the potential to improve the NWM.

OUTCOMES: The outcome of this project will be direct use of satellite soil moisture products within the NWM.

REFERENCES

Zhan, X, L Fang, J Liu, C Hain, J Yin, et al, Fusing Microwave and Optical Satellite Observations for High Resolution Soil Moisture Data Products. 2017 IEEE International Geoscience and Remote Sensing Symposium, July 23–28, 2017, Fort Worth, Texas, USA.

Meeting Participants

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Cherry, Jessica	NWS
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Jacobs, Aaron	NWS
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Streubel, Dave	NWS
Szoke, Ed	NWS
Vukicevic, Tomi	NWS
Xie, Pingping	NWS
Zhao, Limin	OSPO
Chang, Paul	STAR
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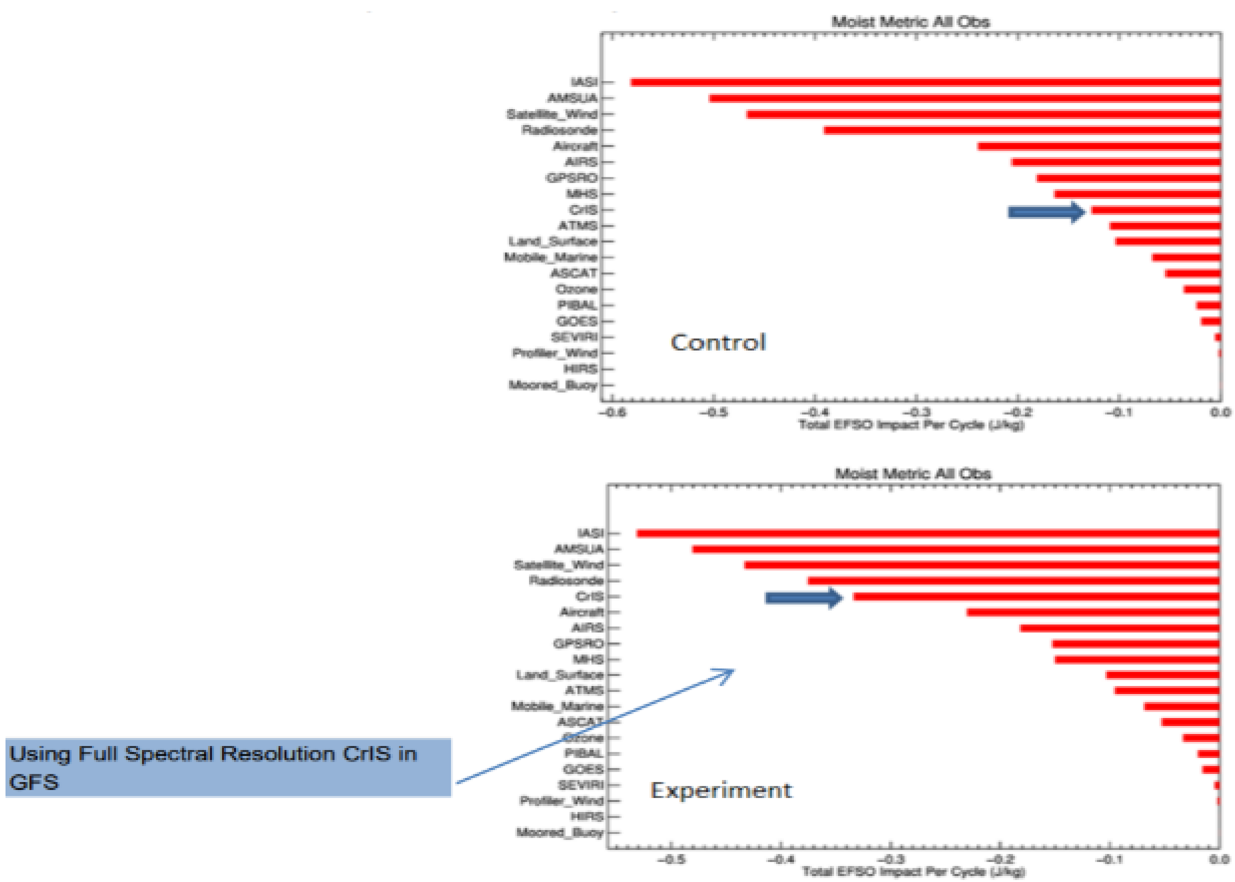
NUMERICAL WEATHER PREDICTION IMPACT STUDIES AND CRITICAL WEATHER APPLICATIONS INITIATIVE



Support improvements in NWP by better use of satellite observations in global and regional models. Adding 20 channels and adjusting assimilation weights moved CrIS from 9th to 5th.

MOTIVATION:

Numerical Weather Prediction (NWP) forms the basis for forecasts from local to global scale, including those for winter storms, hurricanes, convection, marine weather, and aviation applications. NWP models ingest atmospheric and oceanic observations as initial conditions, over 85% of which are from microwave and infrared sounders. Studies on the impact of improved CrIS and ATMS data assimilation in operational NWP models, such as the Global Forecast System (GFS) and the HRRR, enable performance evaluation in context with legacy sounders. This provides feedback on instrument capabilities, helping determine the impact of additional polar-orbiting sounder data to NWP.

WHO WE ARE

The Numerical Weather Prediction (NWP) Impact Studies and Critical Weather Applications Initiative began in October 2015 in order to bring together scientists working to incorporate JPSS data into NWP models, especially those used for critical weather purposes. Currently, there are eight projects in the NWP initiative. Members include representatives from the Center for Satellite Applications and Research (STAR), Cooperative Institute for Meteorological Satellite Studies (CIMSS) at the University of Wisconsin - Madison, Naval Research Laboratory (NRL), Earth Science Research Laboratory (ESRL), and University of Maryland.

WHAT WE DO:

Improved use of JPSS sounder data in NWP models will include instrument performance, improved data assimilation methods, impacts of data latency and improved error characterization. Projects in this initiative aim to exploit the benefits of the 50-minute separation between the Suomi NPP and NOAA-20 orbits. Additionally, projects will work to improve uncertainty characterization of S-NPP/JPSS products in data assimilation and NWP. Our research area ranges from improvement of tropical cyclone forecast capabilities using the JPSS data suite, satellite based hurricane intensity estimation in JPSS/GOES-R era to Suomi NPP and JPSS data assimilation improvements, and the assimilation of CrIS radiances in GSI for better forecasts of high impact weather events.

Focus Areas:

- Calibration/Validation
- Assimilation
- Forecast improvement
- Regional and Global models
- New Observing Systems

WHO WE WORK WITH

The main stakeholders include the Joint Center for Satellite Data Assimilation, NCEP, and NWS WFOs. The projects also benefit the aviation, severe weather, and renewable energy communities.

WHEN WE MEET

Our initiative meets on a quarterly basis. Each quarterly meeting focuses on two or three individual projects. During this time the highlighted projects present their results and get feedback from stakeholders and other project members. Collaboration and open discussion is encouraged.

MAJOR ACCOMPLISHMENTS

The Numerical Weather Prediction (NWP) Impact Studies and Critical Weather Applications Initiative supported studies have been very successful in demonstrating applications of ATMS and CrIS in improving both tropical cyclone track and intensity forecasts. Improvements were made to data selection and uncertainty of numerical weather prediction models via assimilation of ATMS, CrIS, and VIIRS data including enhancement of operational ATMS/CrIS usage with the NRL Numerical Weather Prediction (NWP) model and data assimilation systems.

PROJECT(S):

Our projects work to further the scientific advancement of the use of JPSS satellite data to support critical weather forecasting and numerical modeling efforts in NOAA and beyond. The following section presents summaries of our projects:

- **CRTM Development for Direct OMPS UV Radiance Assimilation**
- **Using JPSS Moisture and Temperature Retrievals to improve NearCasts of Geostationary Moisture and Temperature Retrievals**
- **Advanced EFSO-based QC Methods for Operational Use and Agile Implementation of New Observing Systems**
- **ATMS/CrIS Calibration and Validation and Assimilation Improving Correlated Error, Clouds, and the Surface**
- **Improving the Assimilation of CrIS Radiances in Operational NWP Models by Using Collocated High Resolution VIIRS Data**
- **Quantifying NCEP's GDAS/GFS Sensitivity to CrIS Detector Differences**
- **Enhancement of direct broadcast satellite radiance assimilation capabilities for regional and global rapid-update models and assessment of forecast impact**
- **Support of NPP and JPSS Data Assimilation Improvements and Data Denial Experiments**

CRTM Development for Direct OMPS UV Radiance Assimilation

Changyong Cao, Benjamin Johnson, and Quanhua (Mark) Liu

WHY IS THIS RESEARCH IMPORTANT?

Current Numerical Weather Prediction (NWP) has shown a skill for forecasts up to 5-6 days in advance. However, many applications require longer forecasting periods such as 9-10 days, which would provide significant societal benefits such as decision making on both business and leisure activities. The errors in present-day forecasts are especially large in the vicinity of jet streams. At mid and high latitudes, the jet streams play a major role in the formation and steering of tropospheric weather systems, including large-scale thunderstorm complexes and hurricanes.

NWP centers worldwide are planning to extend their data assimilation and forecasting codes to provide a more realistic treatment of the stratosphere. A crucial component of a more realistic treatment of the stratosphere must include the use of daily measurements of the ozone distribution instead of an ozone climatology (Hornstein et al. 2002). Ozone plays a crucial role in the series of intricate feedback mechanisms that dynamically link the troposphere and the stratosphere.

GOAL: To develop the Ultraviolet (UV) capability for directly assimilating the Suomi NPP/NOAA-20 OMPS radiance data in NCEP Gridpoint Statistical Interpolation (GSI) for weather forecasting.

RATIONALE: Currently, the assimilation of ozone information from satellites is carried out only in retrieval space. There are two major limitations of assimilation of ozone retrieval products. One is that retrieval is an ill-posed problem and the result may depend on the first guess. Another issue is the inconsistency, for example the inconsistency between OMPS and CrIS ozone retrievals. In addition, the spectral radiance measurements contain rich information about the atmospheric chemistry which may not be fully kept after retrievals.

OUTCOMES: Enhanced use of satellite observations from the JPSS OMPS instrument. The new capabilities developed will enable the CRTM to assimilate daily measurements of the ozone field.

REFERENCES

Flynn, L., C. Seftor, J. Larsen, and P. Xu (2006), Introduction to the Ozone Mapping and Profiler Suite (OMPS), in Earth Science Satellite Remote Sensing Vol.1: Science and Instruments, edited by J. J. Qu et al., Springer, Berlin, ISBN: 978-3-540-35606-6. Also http://npp.gsfc.nasa.gov/omps.html.

Heidinger, A. K., O. Christopher, R. Bennartz, T. Greenwald (2006), The Successive-Order-of Interaction Radiative Transfer Model. Part I: Model Development, J. Appl. Meteorol., 45, 1388-1402.

Hornstein, J, E.P. Shettle, R.M. Bevilacqua, et al., 2002. The Ozone Mapping and Profiler Suite-Assimilation Experiment (OMPS-AE), Geoscience and Remote Sensing Symposium, 2002. IGARSS '02. 2002 IEEE International.

Using JPSS Moisture and Temperature Retrievals to improve NearCasts of Geostationary Moisture and Temperature Retrievals

Lee M. Cronce and Ralph A. Petersen

WHY IS THIS RESEARCH IMPORTANT?

Vertical profiles of moisture and temperature are vital to understanding the rapidly changing vertical and horizontal structure of the atmosphere at any given location and time. It is well known that small-scale horizontal and vertical variations in moisture and temperature affect the stability of the atmosphere directly influencing the observed weather. There exist, however, only a few robust data sets of these atmospheric profiles, especially at asynoptic times.

Satellites, radiosondes, and aircraft are the main sources of these data, but their benefits are not realized to their full extent due to spatial, temporal, fiscal, and data assimilation limitations. Radiosondes offer the most complete vertical resolution, but they are limited to mainly twice-a-day launch standards, and their spatial coverage is very coarse over CONUS and nonexistent over the surrounding OCONUS areas. Aircraft offer valuable data up to flight level but, many do not have suitable moisture sensors installed, limiting observations to temperature only. GEO satellite-based profiles offer a much more continuous and spatially detailed representation of the atmosphere due to both full CONUS and OCONUS coverage at higher spatial resolution (~10 km) compared to the radiosonde network (~100s of km) and at a higher temporal frequency (5-60 minutes for satellite, compared to 12 hours for radiosondes). Even with a coarser vertical resolution, these data (especially the moisture profiles) have been shown to be critical in isolating areas where/when severe convection is expected to occur in the next few hours. However, GEO-based profiles are not available in cloudy regions. Moreover, GEO observations are seldom used in operational NWP systems over land.

GOAL: (1) To alleviate the deficiencies noted in the short-range geostationary (GEO) driven forecasting model, or nearcasts, by incorporating JPSS (NUCAPS) moisture and temperature retrievals into the analysis and forecast system. (2) Provide an effective means for forecasters to use satellite moisture information over land that is not fully incorporated in NWP assimilation.

RATIONALE: Forecasters in the US and abroad have favorably evaluated the CIMSS NearCast system, a short-range, observation-driven model originally envisioned to analyze and project forward in time GOES satellite-based observations of moisture and temperature to support operational very-short-range predictions of hazardous weather events. However, the lack of consistency in NearCast products due to gaps in cloudy regions is a major drawback. These gaps, which limit useful information to cloud-free areas, are inherent in the GOES atmospheric profiles as the satellite retrievals are produced using infrared spectral band data. The NearCast system has also been adapted for use in high-latitude regions using retrievals from polar orbiting satellites. The assimilation of JPSS (NUCAPS) moisture and temperature retrievals into the analysis and forecast system should alleviate the deficiencies, and provide an effective means for forecasters to use satellite moisture information over land that is not fully incorporated in NWP assimilation. .

OUTCOMES: Enhanced use of JPSS moisture and temperature retrievals in operational forecast services.

The availability of an independent tool to monitor the performance of more complex NWP systems in real time.

REFERENCES

Gravelle, C. M., J. R. Mecikalski, W. E. Line, K. M. Bedka, R. A. Petersen, J. M. Sieglaff, G. T. Stano, and S. J. Goodman, 2016: Demonstration of a GOES-R satellite convective toolkit to "bridge the gap" between severe weather watches and warnings: An example from the 20 May 2013 Moore, Oklahoma, tornado outbreak. Bull. Amer. Meteor. Soc., 97, 69–84

Goldberg, M., 2017: The value of polar satellite direct broadcast data for nowcasting and short range weather forecasting. 2017 EUMETSAT Meteorological Satellite Conf., Keynote address, Rome, Italy, 2-6 October 2017

Advanced EFSO-based QC Methods for Operational Use and Agile Implementation of New Observing Systems

Eugenia Kalnay, Tse-Chun Chen, and Kathryn Shontz

GOAL: To expedite the research to operations transition of a new observing system or asset through end-to-end application of the demonstrated benefits of applying EFSO and PQC to data assimilation. This project will complete the operational testing of current JPSS PGRR EFSO/PQC project at NCEP and will expand the ability of NESDIS to estimate the impact of observations as a quantitative complement to Observing System Experiments (OSEs).

RATIONALE: Ensemble Forecast Sensitivity to Observations with Proactive Quality Control (EFSO/PQC) is an efficient and exceedingly powerful method that can identify the beneficial or detrimental impact of each individual observation which is assimilated into a Numerical Weather Prediction (NWP) model. EFSO/PQC determines this independently of the presence or absence of any other observation, meaning that results on the critical impact of any assimilated observing system can be simultaneously obtained from a single model run.

OUTCOMES: Demonstrate a new path forward in operational data assimilation, implement an agile and accelerated approach to evaluate the quality of new observing systems, rapidly select optimal assimilation data sets, estimate the optimal observational error variance, and monitor all the observations for detrimental episodes. Based upon successful offline demonstrations completed as part of the previous JPSS PGRR project, an operational transition of the EFSO/PQC tool to NWS/NCEP will be completed. Delivery of the monitoring and observing system experiment capabilities to NESDIS as collaborative tools to improved satellite observing system impact estimation will be made. Used jointly across NOAA, EFSO/PQC can change the framework for operational data assimilation and create new opportunities to enhance the national satellite and forecasting enterprise.

REFERENCES

Kalnay, E., Ota, Y., Miyoshi, T., and Liu, J. A simpler formulation of forecast sensitivity to observations: application to ensemble Kalman filters. Tellus A 64 (oct 2012), 1–9.

Ota, Y., Derber, J. C., Kalnay, E., and Miyoshi, T. Ensemble-based observation impact estimates using the NCEP GFS. Tellus A 65 (sep 2013), 20038.

Lien, G.-Y., Hotta, D., Kalnay, E., Miyoshi, T., and Chen, T.-C. Accelerating assimilation development for new observing systems using EFSO.

ATMS/CrIS Calibration and Validation and Assimilation Improving Correlated Error, Clouds, and the Surface

Bryan Karpowicz, Ben Ruston, Nancy Baker and Steve Swadley

WHY IS THIS RESEARCH IMPORTANT?

Since 1995, the Naval Research Laboratory in Monterey California (NRL-MRY) has been producing datasets and imagery from a constellation of low earth orbiting (LEO) and geostationary (GEO) satellites for distribution to the Department of Defense (DoD) and public. The CrIS and ATMS data from Suomi NPP and NOAA-20 are ingested at NRL Monterey via FNMOC which receives data from NESDIS/AFWA bent-pipe data feed. In previous efforts partially funded through JPSS PGRR, correlated observation errors of ATMS and CrIS aboard S-NPP have been included into the NAVGEM DA system. With design improvements to both instruments aboard NOAA-20, a re-evaluation of the covariance matrices following Desrozier et al. 2005 needs to be performed, and likely new covariance matrices will be required for both instruments aboard NOAA-20.

GOAL: Foster coordinated plans for assimilation of data produced by the Suomi NPP and NOAA-20 to enhance the use of the ATMS and CrIS sensors. To explore enhancement of operational ATMS/CrIS usage, the NRL Numerical Weather Prediction (NWP) model and data assimilation systems will be used.

RATIONALE: The ATMS Suomi NPP data requires application of both calibration and spatial noise reduction strategies to achieve the rigorous signal-to-noise requirement necessary for NWP applications. With design improvements made to ATMS onboard NOAA-20, these strategies need to be re-evaluated and investigated. Further, with the transition to the CrIS full spectral resolution (CrIS-FSR) data NRL has completed a careful re-evaluation of channel selection, observation error, and quality control but as the CrIS-FSR data is available in real time, investigations into better use of the full spectrum is ongoing and will be continued. The addition of allsky assimilation offers an opportunity for synergy between the high spectral resolution of CrIS and high spatial resolution of VIIRS for detecting cloud fraction and further improving all-sky assimilation of CrIS. Further, due to the 50-minute separation between Suomi NPP and NOAA 20, there is an opportunity highlight the benefits of increased global coverage.

OUTCOMES: Near real-time operation of the NRL ATMS NOAA-20 RDR Diagnostics and Calibration Monitoring System, re-evaluation of the CrIS channel selection, bias corrections, observation error, and quality control expanding spectral usage of CrIS-Full Spectral Resolution data stream and development of all-sky assimilation of ATMS and CrIS.

REFERENCES

Karpowicz, B. M., B.C. Ruston, S.D. Swadley, “Microwave Radiance Assimilation at NRL: Advanced Techniques, Developments and Future Sensors,” 21st International TOVS Study Conference, Darmstadt Germany, 2017.

Ruston, B. C. and T. H. Vonder Haar, 2004: Characterization of Summertime Microwave Emissivities from the Special Sensor Microwave Imager over the Conterminous United States. Journal of Geophysical Research, 109, D19103, 13pp.

Wessel, J., R. Farley, A. Fote, Y. Hong, G. Poe, S. Swadley, B. Thomas, and D. Boucher, 2008: Calibration And Validation of the DMSP SSMIS Lower Atmospheric Sounding Channels, IEEE Trans. Geosci. Rem. Sens., 46, (4), pp. 946-961.

Kunkee, D., S. Swadley, G. Poe, Y. Hong, 2008: Special Sensor Microwave Imager/Sounder (SSMIS) Radiometric Calibration Anomalies, IEEE Trans. Geosci. Rem. Sens., 46, (4), pp. 1017-1031.

Campbell, W. F., E. A. Satterfield, B. Ruston, and N.L. Baker, 2017: Accounting for Correlated Observation Error in a Dual-Formulation 4D Variational Data Assimilation System. Mon. Wea. Rev., 145, 1019-1032.

Improving the Assimilation of CrIS Radiances in Operational NWP Models by Using Collocated High Resolution VIIRS Data

Jun Li

WHY IS THIS RESEARCH IMPORTANT?

Observations over the oceans that are assimilated into the operational NWP models are very important for improving forecasts of TC intensity and path change. The AIRS onboard NASA's EOS Aqua platform, the IASI onboard the European Metop-A/-B satellites, and the CrIS onboard the Suomi NPP and NOAA-20 provide unprecedented information about atmospheric temperature and moisture profiles with high vertical resolution and good accuracy. Such information is very important for the understanding and prediction of the genesis, intensity, motion, rainfall potential, and landfall impacts of tropical weather systems.

Although satellite advanced IR sounder measurements have been used in NWP models and provided positive impact on weather forecasting through DA, improving the utilization of hyperspectral IR sounder radiances, especially the data over cloudy regions, remains of high interest to operational NWP centers. Currently, only a very small percentage (less than 2%) of advanced IR sounder observations is assimilated by operational NWP models.

GOAL: Develop new approaches for improving CrIS radiance assimilation into NOAA operational NWP models.

RATIONALE: CIMSS scientists have developed the NRT SDAT, successfully tested the latest version of HWRF on S4, developed VIIRS-based CrIS cloud-clearing algorithm and software, and showed the positive impact of CCRs on TC forecasts with SDAT. However, SDAT is a research system for developing and demonstrating prototype data assimilation (DA) methodologies (e.g., VIIRS-based CrIS CCRs), its progress does not necessarily reflect the effectiveness of DA in NOAA's operational numerical weather prediction (NWP) models such as Hurricane Weather Research and Forecast (HWRF) and Global Forecast System (GFS). Although tests in SDAT show relative improvements, it is difficult to judge the true value of data and assimilation techniques in operational NWP models. Testing needs to occur in a modeling system as close to operations as possible.

OUTCOMES: Improved forecasts of high impact weather (HIW) events through better utilization of CrIS radiances in NOAA operational NWP models.

REFERENCES

Li, Jun, P. Wang, H. Han, J. Li, and J. Zheng, 2016: On the assimilation of satellite sounder data in cloudy skies in the numerical weather prediction models, Journal of Meteorological Research. 30, 169-182.

Li, Jun, et al. 2017: Impact of assimilating the VIIRS-based CrIS cloud-cleared radiances on hurricane forecasts. ITSC21, 28 Nov. – 05 Dec 2017, Darmstadt, Germany.

Wang Pei, Jun Li, Z. Li, A. H. N. Lim, Jinlong Li, T. J. Schmit, and M. D. Goldberg, 2017: The Impact of Cross-track Infrared Sounder (CrIS) Cloud-Cleared Radiances on Hurricane Joaquin (2015) and Matthew (2016) Forecasts, Journal of Geophysical Research - Atmospheres, 122, DOI: 10.1002/2017JD027515.

Quantifying NCEP's GDAS/GFS Sensitivity to CrIS Detector Differences

Agnes Lim, Sharon Nebuda and Dave Tobin

WHY IS THIS RESEARCH IMPORTANT?

Satellite observations used in data assimilation systems can have errors that are associated with the observation operator and radiative transfer models. These errors may also stem from instrument design or calibration, quality control procedures, representativeness of the radiance and model fields. Data assimilation systems do not account for all possible error correlations in satellite radiance data.

GOAL: To understand at what level inter-detector biases begin to affect NWP analysis and forecast systems.

RATIONALE: The current approach to address observations that exhibit correlated error is to merely inflate the error covariance matrix or use spectral and/or spatial thinning so that the error correlations are diminished. However, neglecting spatial error correlation in data assimilation can lead to suboptimal analysis when high-density observations are used (Liu and Rabier, 2003). Therefore, sensor requirements that minimize horizontal error correlations by design can have a beneficial impact for data users.

OUTCOMES: Determination of the inter-detector matching requirements of the Cross-track Infrared Sounder (CrIS) necessary to avoid negative impact on the National Centers for Environmental Prediction (NCEP) Global Forecast System Data Assimilation System (GDAS).

REFERENCES

Liu Z-Q and F. Rabier, 2003: The potential of high density observations for numerical weather prediction: A study with simulated observations, Q. J. R. Meteorol. Soc. 129(594), 3013-3.035

Enhancement of direct broadcast satellite radiance assimilation capabilities for regional and global rapid-update models and assessment of forecast impact

Haidao Lin, Stephen Weygandt, and Curtis Alexander

WHY IS THIS RESEARCH IMPORTANT?

Traditionally, the ability to assimilate polar orbiter satellite data in the rapidly updating regional models has been very limited due to the very short data cutoff for these models (often of order 30 min.) combined with the long latency in the availability of these observations (often > 2 hour). This is a significant shortcoming, as short-range forecasts from these models are the backbone of much of the day-to-day weather guidance and very short-range hazard warnings provided to the citizens on a daily basis.

GOAL: to optimize the use of direct broadcast data in the hourly updating RAP and HRRR models and apply traditional and novel verification techniques (along with subjective evaluation) to provide comprehensive documentation of the forecast impact from these data.

RATIONALE: The advent of direct broadcast capabilities for satellite observation transmission has ushered in a new era for use of satellite radiance data in many of the rapidly-updating, regional weather prediction models. Evaluation of and improvement in the use of these data in the hourly updated NOAA operational RAP and HRRR models provides an ideal setting for maximizing the utility of these satellite radiance data and this new direct broadcast data dissemination system.

OUTCOMES: Enhanced skill for short-range forecasts, including better predictions of hazardous weather, such as severe thunderstorms and high aviation impact weather.

REFERENCES

Lin, H., S.S. Weygandt, S.G. Benjamin, and M. Hu, 2017: Satellite Radiance Data Assimilation within the Hourly Updated Rapid Refresh. Wea. Forecasting, 32, 1273–1287, https://doi.org/10.1175/WAF-D-16-0215.1.

Lin, H., S.S. Weygandt, A.H. Lim, M. Hu, J.M. Brown, and S.G. Benjamin, 2017: Radiance Preprocessing for Assimilation in the Hourly Updating Rapid Refresh Mesoscale Model: A Study Using AIRS Data. Wea. Forecasting, 32, 1781–1800, https://doi.org/10.1175/WAF-D-17-0028.1

Support for Suomi-NPP and JPSS Data Assimilation Improvements and Data Denials Experiments

James Jung and Sharon Nebuda

WHY IS THIS RESEARCH IMPORTANT?

Gridded datasets of satellite observations are key for weather analysis and forecasting. Satellite data provide approximately 90% of all assimilated data for NWP as they give global atmospheric information, reporting in both remote areas and over the ocean. Operational NWP models, such as the Global Forecast System (GFS) run at the NOAA National Centers for Environmental Prediction (NCEP) rely heavily on the latest data assimilation techniques to ensure accurate results.

GOAL: to continue to facilitate the transition to, and improve the use of, the NOAA-20 and Suomi NPP Cross-track Infrared Sounder (CrIS) full spectral resolution (FSR, 2211 channels) in the National Centers for Environmental Prediction (NCEP) weather forecast models including the Global Data Assimilation System / Global Forecast System (GDAS/GFS).

RATIONALE: One of the concerns within the Numerical Weather Prediction community is the differences between the nine CrIS detectors. If the calibration between the nine CrIS detectors is not consistent, specific detectors will be rejected from the assimilation system. The European Center for Medium Range Forecast (ECMWF) is the most aggressive with this criteria by using only one detector from IASI (Collard and McNally 2006) and only using four detectors from CrIS (Eresmaa, et al., 2017).

OUTCOMES: To improve the use of the longwave channels and exploit the information from the higher spectral resolution midwave and shortwave channels.

Improved weather model initialization, and potentially forecasts, from the enhanced information content.

REFERENCES

Jung, J. A., and Coauthors 2017: Preparing for CrIS Full Spectral Resolution Radiances in the NCEP Global Forecast System, Proceeding of the 21st International TOVS Study Conference, Darmstadt, Germany, 29 November – 5 December 2017.

Jung, J. A. and coauthors, 2017: Advancements in CrIS Data Assimilation, 2017 JPSS Annual Science Team Meeting, College Park, MD., 14-18 August 2017.

Collard, A. D., and A. P. McNally, 2009: The assimilation of Infrared Atmospheric Sounding Interferometer radiances at ECMWF, Q. J. R. Meteorol. Soc., 135, 1044-1058.

Eresmaa, R., J. Letertre-Danczak, C. Lupu, N. Bormann and A. P. McNally, 2017: The assimilation of Cross-track Infrared Sounder radiances at ECMWF, Q. J. R. Meteorol Soc., 143, 3177-3188.

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OCEANS AND COASTS INITIATIVE

Algae Blooms and Sediment Plumes in the Gulf of Mexico, January 27, 2015. Credit NOAA/NESDIS/STAR
https://www.star.nesdis.noaa.gov/jpss/oceancolor.php

MOTIVATION:

Understanding ocean, coastal and inland water processes, both physical and biological, are essential to achieving NOAA's mission including improved extreme weather forecasting, ecological forecasting, and ecosystem-based fisheries management. This Initiative supports use of ocean data and derived products to include: VIIRS Sea Surface Temperature (SST) and Ocean Color Radiometry (OCR) and other observations to advance NWS, NMFS, NOS, and OAR mission applications. In particular, users have identified needs for multi-sensor data sets, long-term time series datasets and higher level, value-added products for both near real-time and long-term time series to support a broad range of scales from small local watersheds to ocean basins.

WHO WE ARE

Principal investigators include scientists from the NOAA Cooperative Institutes such as CICS-CREST and other, collaboration with National Ocean Service NCCOS and Center for Monitoring and assessments; NESDIS Star Coast Watch and Ocean Watch program; NOAA Fisheries science centers.

WHAT WE DO:

Members of this initiative work to improve upon and develop methods to create multi-sensor products and extend existing products such as SST to higher latitudes and gap filling products exploiting neural nets. Additionally they create data portals so that data is discoverable and in multiple formats for ease of use. Finally they develop tools for forecast and assessments using the Real-time Ocean Forecast System.

We provide our consumers with fit-for-purpose, accurate, consistent and timely, and long-term time series ocean data and derived products. For our NMFS and NOS consumers, we provide products derived from VIIRS – the only instrument that makes oceanographic measurements, i.e., surface chlorophyll and sea-surface temperature. Within NMFS and NOS VIIRS ocean color data is used in a variety of different applications, many of which are not for near real time application.

Focus Areas:

We focus on the following NOAA service areas: Modeling and Forecasting Physical & Biological Ocean and Coastal Dynamics, Harmful Algal Blooms (HABs), Water Quality, and Ecological Forecasting, Living Marine Resources, and Ocean Acidification and Air Quality

Modeling Analysis and Forecasting Physical & Biological Ocean and Coastal Dynamics:

- Incorporation of biogeochemical feedbacks, using ocean color and other data, help improve ocean model physics and skill. Multi-sensor SST analyses both real-time and long-term, which incorporate VIIRS SST and other data, may benefit uses from extreme weather forecasting to ecological forecasting.
- Living Marine Resources: NMFS and partners can benefit from JPSS data for regional and global models and assessments, particularly as fisheries management transitions from traditional stock assessments to Integrated Ecosystem Assessments and Ecosystem-Based Management. Ocean

satellite products, to include multi-sensor over multiple platforms, can be used to enhance field sampling for real time products for fronts, anomalies, and other capabilities.

- Carbon and Ocean Acidification: OAR's focus on ocean acidification includes validation and methods development for biogeochemical components in the carbon flux/cycle. These developments support fast response decision making, such as aquaculture management as well long term global implications. Product development from OCR and SST to support inorganic/organic components of carbon cycle models such as: color as proxy for salinity in coastal waters, primary productivity, and others.
- Water Quality and Ecological Forecasting: modeling from local to national scale to enable forecast of high impact biological events. Data anomaly and trend detection to support ecological forecasting and event monitoring are also encouraged. Additional areas are water quality and ecological forecasting.

WHO WE WORK WITH

Consumers of NOAA satellite oceanographic data are many. We work with Fisheries Science Centers and Regional Offices and NOS Operational Forecast Systems users, US Integrated Ocean Observing System (IOOS), researchers at universities and international users. We also work with the NMFS and NESDIS, as well as the NOAA Coral Reef Conservation Program, which uses our VIIRS SST data to generate a new climatology for their bleaching alert and monitoring products for coral reef managers around the globe. Our VIIRS ocean color data is utilized by the NOS OAR and the NWS. The NWS, for example, uses our VIIRS Ocean Color data to train a neural network to estimate gap-free, consistent ocean color fields (e.g., chlorophyll-a) for assimilation into a pre-operational environment for NOAA's operational ocean models. The NOAA Air Resources Laboratory (OAR) derives the global distribution of marine isoprene, which is then incorporated into emission models for the National Air Quality Forecasting Capability (NAQFC).

WHEN WE MEET

The O&C initiative projects present project information and status updates during the larger NOAA Ocean Color Coordinating Group (NOCCG). This team meets biweekly. Additionally Principal Investigators are encouraged to provide presentations during the annual NOAA CoastWatch/OceanWatch meetings.

MAJOR ACCOMPLISHMENTS

Accomplishments to date include the development of repositories and data discovery tools for ocean satellite data.

PROJECT(S):

The following section presents summaries of our projects:

- **CICS-CREST: Extending and Evaluating VIIRS Ocean Color Neural Network Retrievals of Harmful Algal Blooms and IOPs to Complex Inshore, Bay and Inland Waters and Examining Their Applicability to Different Bloom Types**

- **NOAA CoastWatch/OceanWatch: Implement, process and serve JPSS program ocean products tailored for downstream user needs**
- **Multi-sensor high-resolution gridded (super)-collated SST ACSPO L3C/L3S products**
- **Using VIIRS to operationalize dynamic EBFM tools on the U.S. East and West Coasts**
- **Optimization of phytoplankton functional type algorithms for VIIRS ocean color data in the Northeast U.S. Continental Shelf Ecosystem**
- **Assimilating NOAA VIIRS Data into Near-Real-Time Ocean Models to Support Fisheries Applications off the US West Coast**

CICS-CREST: Extending and Evaluating VIIRS Ocean Color Neural Network Retrievals of Harmful Algal Blooms and IOPs to Complex Inshore, Bay and Inland Waters and Examining Their Applicability to Different Bloom Types

Sam Ahmed and Alex Gilerson

WHY IS THIS RESEARCH IMPORTANT?

HABs pose serious problems in many parts of the US as well as other countries. In the WFS where the problem is often particularly serious, Karenia brevis (KB) HABs often occur at the height of the tourist season with serious health (respiratory), fish kill and major economic impacts. Timely detection and tracking of these blooms is important to local authorities for beach and health warnings. Satellite detection presents a potentially cost effective approach, and a start was made using the predecessor MODIS-A satellite. The application of the successor VIIRS satellites is hampered by the lack of 678 nm chlorophyll fluorescence channel used in the successful (nFLH) retrieval algorithm in MODIS-A. Neural network (NN) ocean color algorithms derived from the VIIRS sensors have proved effective for retrievals of IOPs and Karenia brevis (KB) HABs in the West Florida Shelf (WFS). The NN technique was developed to make up for the lack of a 678 nm chlorophyll fluorescence band on VIIRS, which had been key to the successful normalized fluorescence height (nFLH) algorithm used for HABS retrievals by MODIS-A.

Using the NN approach to enhance the use of VIIRS JPSS data in retrieving [Chla] and HABs would be of direct benefit to end user applications, including the NOAA NCCOS and MOTE Marine Laboratories, who need regular and timely data on KB HABs distributions and concentrations in the WFS, as inputs for processing their forecasts and beach warnings and other information, which is supplied either to local authorities for further action, or directly to the public. Such applications are not limited to the WFS, but are of both nationwide and international interest in many areas where similar HABs problems exist. Therefore, establishing effective operational retrieval procedures for these applications with VIIRS would greatly enhance its utility and appreciation for a large variety of users.

GOAL: to exploit the demonstrated potential advantages of NN retrievals in three phases:

(i) VIIRS NN retrievals of KB HABS will be progressed from research toward practical operations for use by NOAA and others.

(ii) Investigate the potential for extension of the advantages of VIIRS NN techniques to more general retrievals of KB and IOPs, including [Chla], CDOM, backscatter, in different waters, e.g KB in TX. LA, the Atlantic coasts, and globally, with the goal of expanding new potential uses for VIIRS.

(iii) Evolve and codify NN retrieval processes into a simplified readily usable format and software code (for use by NCCOS and others) to facilitate their operational use.

RATIONALE: The NN technique was developed to make up for the lack of a 678 nm chlorophyll fluorescence band on VIIRS, which had been key to the successful normalized fluorescence height (nFLH) algorithm used for HABS retrievals by the predecessor MODIS-A satellite. NN uses available VIIRS bands at 486, 551 and 671 nms. Research has shown these bands to be less vulnerable to atmospheric correction inadequacies and the presence of high CDOM concentrations, due to their longer wavelengths, which are two important factors that detrimentally affect the deeper blue bands used in other VIIRS algorithms, and which generally make them ineffective in complex coastal and in-shore waters.

OUTCOMES: enhanced utility and demand for VIIRS, by extending its retrievals to other complex regional and global waters where its use is presently limited.

An evolved and codified NN retrieval processes into a simplified readily usable format and software code to facilitate operational usage.

REFERENCES

Richard P Stumpf, Michelle C Tomlinson, Julie A Calkins, Barbara Kirkpatrick, Kathleen Fisher, Kate Nierenberg, Robert Currier, and Timothy T Wynne, “Skill assessment for an operational algal bloom forecast system,” Journal of Marine Systems, 76(1), 151-161 (2009).

Ruhul Amin, Jing Zhou, Alex Gilerson, Barry Gross, Fred Moshary, and Samir Ahmed, “Novel optical techniques for detecting and classifying toxic dinoflagellate Karenia brevis blooms using satellite imagery,” Optics express, 17(11), 9126-9144 (2009).

NOAA CoastWatch/OceanWatch: Implement, process and serve JPSS program ocean products tailored for downstream user needs

Paul DiGiacomo

WHY IS THIS RESEARCH IMPORTANT?

Many key environmental parameters for the open ocean are determined on a routine and sustained basis from well-validated algorithms including SST, sea surface height, OC, sea ice, ocean winds, and roughness of the ocean surface (e.g., oil spills), providing frequent and synoptic coverage. Retrievals in coastal and near-shore waters (including the Great Lakes) continue to be an area of active research and development, but many products are ready for use in research and science-based applications. Gaining access to and utilizing these satellite data can be daunting to the non-specialist, however.

NOAA/NESDIS has a duty to provide satellite data products in a form that support NOAA missions. This means the need to produce and provide easy access to higher level data and information products based on satellite observations. Making such higher-level satellite-based ocean products available to users outside of NOAA (e.g., other federal agencies, state and local governments, researchers, students, commercial users, and the public) is also imperative to maximizing societal benefits derived from the already impressive and ever-growing constellation of earth-observing satellites.

GOAL: to develop and implement an "all-in-one" CW Data Portal, produce tailored ocean color products, reformat and distribute the VIIRS DINEOF chlorophyll, and develop, produce and distribute global common-gridded (mapped for equatorial and polar projections) full-resolution L3 in downloadable sector files.

RATIONALE: While NOAA Line Office scientists and resource managers generally appreciate the potential utility and power of satellite data for their applications, they are not necessarily well-versed with satellite remote sensing and therefore may be uncomfortable with or lack the tools and skills required to work efficiently with basic-level (i.e., minimally processed) satellite data products.

OUTCOMES: Easy to find and centrally placed value-added near real time and mission long products, as well as consistent, long-term science quality time-series products, including products that combine data from sensors from multiple missions.

REFERENCES

Stumpf, R. P., M. E. Culver, P. A. Tester, M. Tomlinson, G. J. Kirkpatrick, B. A. Pederson, E. Truby, V. Ransibrahmanakul and M. Soracco (2003). "Monitoring Karenia brevis blooms in the Gulf of Mexico using satellite ocean color imagery and other data." Harmful Algae 2(2): 147-160.

Multi-sensor high-resolution gridded (super)-collated SST ACSPO L3C/L3S products

Irina Gladkova and Alexander Ignatov

WHY IS THIS RESEARCH IMPORTANT?

SST is required in many oceanographic, meteorological and climatological applications, including monitoring of climate variability, operational weather and seasonal forecasting, ocean-atmosphere interaction, military and defense operations, validation and/or forcing of the ocean and atmospheric models, ecosystem assessment, coastal management, tourism, and fisheries. While many of these needs are satisfied by data products from multiple polar and geostationary sensors, many users find it extremely challenging to ingest and make use of all available L2P data, due to swath projection and large data volumes or even much smaller gridded L3U data.

GOAL: to create two new L3 products: collated (L3C; produced from multiple overpasses of the same satellite); and super-collated (L3S; produced from multiple overpasses of all available platforms/sensors over the area).

RATIONALE: Many users find it difficult to work with L2P data, due to swath projection and large data volumes. About 90% of ACSPO users prefer L3U data, which are gridded and much smaller in size (for VIIRS, 0.4GB/day vs. 27GB/day for L2P). However, the L3U data volume and multitude of granules (10min for VIIRS) still remains prohibitive. Coverage from any one individual sensor is limited, due to clouds. Adding observations from other sensors improves coverage by a factor of ~2, but users have to correct for cross-sensor biases, which are regional, view angle specific, and variable in time.

OUTCOMES: Enhanced product will lead to an increase in the the VIIRS L2P/3U users' community.

REFERENCES

Dash, P., A. Ignatov, Y. Kihai. J. Sapper, 2010: The SST Quality Monitor (SQUAM), JTech, 31(1), 1899-1917, doi:10.1175/2010JTECHO756.1.

Cross, J., I. Gladkova, P. Menzel, A. Heidinger, M. Grossberg, 2013: Statistical estimation of a 13.3 micrometer VIIRS channel using multi-sensor data fusion, JARS, 7(1), doi: 10.1117/1.JRS.7.073473.

Gladkova, I., Y. Kihai, A. Ignatov, F. Shahriar, B. Petrenko, 2015: SST Pattern Test in ACSPO Clear-Sky Mask for VIIRS, Remote Sens. Env., 160, 87-98, doi:10.1016/j.rse.2015.01.003.

Ignatov, A., I. Gladkova, Y. Ding, F. Shahriar, Y. Kihai, X. Zhou, 2017, JPSS VIIRS level 3 uncollated SST Product at NOAA, J. Appl. Remote Sens., 11(3), 032405, doi:10.1117/1.JRS.11.032405.

Using VIIRS to operationalize dynamic EBFM tools on the U.S. East and West Coasts

Elliott L. Hazen, Michael G. Jacox, Dale Robinson, Cara Wilson, Steven J. Bograd

WHY IS THIS RESEARCH IMPORTANT?

Balancing sustainable ecological and economic objectives is a continuing challenge for fisheries managers. Static management approaches including marine protected areas are one strategy to regulate human uses of the ocean and safeguard vulnerable species and habitats. However, when species are mobile and associated with dynamic ocean features, static approaches can result in large closures with little conservation gain. This approach may incur high opportunity costs to stakeholders as some activities (e.g. fishing, shipping) are excluded from areas at times when protection is not necessary, for example when the focal species needing protection are absent (e.g. migrating whales). There is often socio-political resistance to placing restrictions on ocean activities that provide significant economic and social benefits, and consequently evidence-based scientific solutions are needed to resolve competing objectives.

GOAL: to predict model output using VIIRS data; compare MODIS- and VIIRS-based predictions during the overlap period; and operationalize the models on VIIRS to ensure they can continue to be used in NMFS EBFM activities.

RATIONALE: Currently EcoCast, Eco4Cast – are two of the main Ecosystem Based Fisheries Management (EBFM) tools currently used to maximize sustainable resource extraction while minimizing risk of adverse interactions between humans and marine species. Both rely on a suite of satellite-based products including temperature and ocean color, both for species distribution model fitting and prediction to predict the spatial distribution of bycatch risk in near real-time, allowing fishers to maintain economically viable harvest of target catch. Historical models were fit using a combination of satellites, with ocean color data derived from SeaWIFS and MODIS-Aqua. Predictions are currently operationalized using MODIS-Aqua data; however continued predictions will require transitioning to VIIRS ocean color products.

OUTCOMES: Proactive management approaches that support sustainable fisheries and that are robust to climate variability and change.

REFERENCES

Breece, M. W., Fox, D. A., Haulsee, D. E., Wirgin, I. I. & Oliver, M. J. (2017) Satellite driven distribution models of endangered Atlantic sturgeon occurrence in the mid-Atlantic Bight. ICES Journal of Marine Science doi.org/10.1093/icesjms/fsx187 (2017).

Erickson, DL Kahnle, A Millard, MJ Mora, EA and others. 2011. Use of pop-up satellite archival tags to identify oceanic-migratory patterns for adult Atlantic sturgeon, acipenser oxyrinchus oxyrinchus mitchell, 1815. Journal of Applied Ichthyology 27:356–365

Optimization of phytoplankton functional type algorithms for VIIRS ocean color data in the Northeast U.S. Continental Shelf Ecosystem

Kimberly Hyde, Colleen Mouw, and Ryan Morse

WHY IS THIS RESEARCH IMPORTANT?

Phytoplankton are critical regulators of key biogeochemical processes and fuel marine food webs through primary production. As such, changes in the timing, location, and/or species composition of phytoplankton blooms can have dramatic consequences on carbon cycling and the fate of primary production. Hence, understanding how phytoplankton communities are changing is of critical importance to managing sustainable fisheries and ocean health. Oceanic remote sensing observations have spatial and temporal resolutions unattainable by ship-based, moored or autonomous platforms, and are a critical component of the long-term monitoring of the physical environment and ecosystem productivity. A variety of remote sensing algorithm approaches have recently emerged that attempt to identify phytoplankton into size classes (PSCs) and functional types (PFTs) at the global scale. However, for use in the Northeast US continental shelf (NES), these algorithms must be optimized to account for local variations in non-algal parameters such as colored dissolved organic matter and suspended particles.

GOAL: to improve satellite derived measurements of phytoplankton composition in the Northeast U.S. Shelf (NES) to support NOAA's mission of ecosystem based fisheries management (EBFM) by using the data in ecosystem status reporting, fisheries production potential models, and end-to-end fisheries ecosystem models.

RATIONALE: The distinct morphology, size, and pigment composition of phytoplankton, modulated by their physiological state, impact light absorption and scattering, allowing them to be detected with ocean color radiometry. Satellite-based radiometric observations provide spatial and temporal resolution unattainable by ship-based, moored or autonomous sampling platforms, and are a critical component of the long-term monitoring of phytoplankton in marine ecosystems.

OUTCOMES: Improved satellite derived measurements of phytoplankton composition in the Northeast U.S. Shelf (NES) to support NOAA's mission of ecosystem based fisheries management (EBFM) by using the data in ecosystem status reporting, fisheries production potential models, and end-to-end fisheries ecosystem models.

REFERENCES

Bailey, S. W., and Werdell, P. J. 2006. A multi-sensor approach for the on-orbit validation of ocean color satellite data products. Remote Sensing of Environment, 102: 12-23.

Bracher, A., Bouman, H. A., Brewin, R. J. W., Bricaud, A., Brotas, V., Ciotti, A. M., Clementson, L., et al. 2017. Obtaining Phytoplankton Diversity from Ocean Color: A Scientific Roadmap for Future Development. Frontiers in Marine Science, 4.

Bracher, A., Hardman-Mountford, N., Hirata, T., Bernard, S., Boss, E., Brewin, R., Bricaud, A., et al. 2015. Phytoplankton Composition from Space: Towards a validation strategy for satellite algorithms p. 40. Greenbelt: NASA Goddard Space Flight Center.

Brewin, R., Lavender, S., Hardman-Mountford, N., and Hirata, T. 2010a. A spectral response approach for detecting dominant phytoplankton size class from satellite remote sensing. Acta Oceanologica Sinica, 29: 14-32.

Assimilating NOAA VIIRS Data into Near-Real-Time Ocean Models to Support Fisheries Applications off the U.S. West Coast

Michael G. Jacox, Steven J. Bograd, Christopher A. Edwards, Elliott L.Hazen, Andrew M. Moore, and Cara Wilson

WHY IS THIS RESEARCH IMPORTANT?

The National Marine Fisheries Service (NMFS) and the Pacific Fisheries Management Council (PFMC) are increasingly striving to implement ecosystem based fishery management, in which a holistic view of the marine ecosystem is used to inform management actions. A key need in support of this effort is the provision of accurate, reliable environmental data at temporal and spatial resolutions that are consistent with ecosystem dynamics and management objectives. To that end, an existing US west coast ocean reanalysis, which combines ocean models with satellite and in situ observations to better estimate oceanographic conditions, is being employed in multiple efforts within the NMFS and the PFMC, as well as the fishing community and other stakeholders in support of fisheries management applications.

GOAL: to develop state-of the- art biophysical ocean reanalyses and use them to provide fisheries-relevant data and derived products to end-users, specifically the PFMC and the NMFS WCRO.

RATIONALE: As physical (e.g., temperature) and biogeochemical (e.g., nutrient, phytoplankton) conditions drive change throughout the marine ecosystem, it is imperative that consistent, reliable biogeochemical data products are developed and maintained for end users in fisheries and elsewhere. In this regard, synergistic use of satellites and ocean models (i.e., in ocean reanalyses) is highly beneficial; satellites provide observations to constrain models and ensure fidelity to nature, while models fill data gaps, resolve the ocean subsurface, and provide a consistent product across periods of changing observation assets.

OUTCOMES: Analyses and products disseminated (i) to the scientific community as a demonstration of the use of JPSS satellite data to inform fisheries management, (ii) to fisheries managers (PFMC and NMFS WCRO) in support of ecosystem-based fisheries management, and (iii) to the general public to promote the utility of NOAA satellite data in improving the sustainability of U.S. fisheries.

REFERENCES

Mattern, J.P., Song, H., Edwards, C.A., Moore, A.M. and Fiechter, J., 2017. Data assimilation of physical and chlorophyll a observations in the California Current System using two biogeochemical models. Ocean Modelling, 109, pp.55-71.

Moore, A. M., M. G. Jacox, W. Crawford, B. Laughlin, C. A. Edwards, and J. Fiechter (2017), The impact of the ocean observing system on estimates of the California Current circulation spanning three decades, Progress in Oceanography, doi:10.1016/j.pocean.2017.05.009.

Song, H., Edwards, C.A., Moore, A.M. and Fiechter, J., 2016b. Data assimilation in a coupled physical-biogeochemical model of the California current system using an incremental lognormal 4-dimensional variational approach: Part 3—Assimilation in a realistic context using satellite and in situ observations. Ocean Modelling, 106, pp.159-172.

RIVER ICE AND FLOODING INITIATIVE

Break-up in the Red River Basin. It seems major flood occurred in Canada. Some inundation was found near Pembina, MN.

MOTIVATION:

Floods are among the most common hazards in the In the United States. Billions of dollars are lost annually, as well as life and property due to flooding events. The areal extent of flood waters are often difficult to define as most floods tend to occur in remote areas, which also presents challenges in getting timely information, and especially in the middle of a crisis. Satellite imagery has proven to be an effect supplement to in-situ methods of defining flood extent.

In Alaska, the possibility of flooding from ice jams on rivers is an annual threat. However, Alaska's vast size and remote location make it difficult to determine the extent of river ice, breakup, and the potential onset of flooding as the ice moves down river into areas where ice jams are frequent occurrences. As a result, Alaska became the natural initial focus of attention.

WHO WE ARE

The River Ice and Flooding Initiative was established in 2013 in response to flooding in Galena Alaska in May. The Initiative includes River Ice and River Flooding Project teams, direct broadcast Subject Matter Experts, and National Weather Service River Forecast Center forecasters.

WHAT WE DO:

We facilitate interactions between NWS RFC forecasters and VIIRS River Ice and Flood Product algorithm developers. These interactions provide opportunities for new or enhanced products to be tested in operational environments in the RFCs. We also work with our user communities to determine the utility and value of our products in response to real-world ice jam and flooding events. In addition, we implement procedures to transition these research capabilities to operations.

Our capabilities in support of flood forecasting and mitigation include near-real-time flood mapping based on the VIIRS imagery. We provide conditions of river ice and standing water (flood) to the RFCs. These conditions include near-real-time flood extent, river/lake ice cover, flood water surface level, and flood water depth. We also provide near-real-time detailed flood maps to FEMA, the U.S. Army Corp of Engineers, and the U.S. Coast Guard. We also provide support to the International Disaster Charter when NOAA data are requested to support flooding events in the global arena.

Focus Areas:

- National and international river basins
- Alaska
- The National Water Center

WHO WE WORK WITH

Our primary consumers are National Weather Service (NWS) River Forecast Centers (RFCs) whom we work with to assist their users with ice and flood products. Based on the success of the VIIRS Flood Product along the Yukon River in Alaska, other RFCs were approached to evaluate our flood product for events along rivers in their areas of responsibilities. Since inception, we've had more RFCs join, and we now support multiple, including Alaska Pacific, North Central, West Gulf, North East and the Missouri River Basin. We also support other decision making bodies such as the Federal Emergency Management Agency (FEMA), and the U.S. Army Corp of Engineers (USACE) by generating products in formats that are compatible with their decision systems. We have also engaged the National Water Center (NWC) to determine what satellite derived flood products can be leveraged.

WHEN WE MEET

We meet virtually throughout the year, at least once a month.

MAJOR ACCOMPLISHMENTS

Near real-time process: The products are running routinely at SSEC and GINA using Suomi NPP direct broadcast data.
Flood/River Ice maps are integrated into AWIPS-II and SSEC's Real Earth.
The initiative also provides critical flood information to the Federal Emergency Management Agency (FEMA), as well as the Army Corps of Engineers (USACE).
VIIRS flood detection capability has been extended to the regions outside of USA, and is now supporting elements of the International Charter for Disasters.

PROJECT(S):

The following section presents a summary of our project "**Development of Global Geostationary-JPSS Flood Mapping Software and Products**".

Development of Global Geostationary-JPSS Flood Mapping Software and Products

Donglian Sun, Sanmei Li, Mike DeWeese and Jay Hoffman

WHY IS THIS RESEARCH IMPORTANT?

When a catastrophic storm hits, the resulting floods can be deadly and cost billions of dollars in economic losses. This highlights the importance of flood monitoring. But more than this, floods are the most frequent natural disasters globally, which indicates the necessity of a global flood mapping system.

In the U.S., floods are responsible for more loss of life and property than any other severe weather event. As noted in the 2018 NOAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters report, in 2017, the U.S. was impacted by 16 separate billion-dollar disaster events whose cumulative damages amounted to $306.2 billion. Of these damage costs, well over $200 billion were incurred, in part, from the catastrophic floods induced by hurricanes Harvey, Irma and Maria.

GOAL: to develop a global geostationary-JPSS flood product at 375-m spatial resolution, construct global flood process and distribution system from Suomi-NPP/VIIRS, NOAA-20/VIIRS, GOES-16/ABI, and Himawari-8/AHI.

RATIONALE: NOAA's flood maps have changed how we measure the evolution and dynamics of flooding by providing high resolution detail over vast areas. This information allows teams on the ground to plan for evacuations and determine where to focus their recovery efforts. The VIIRS flood product has been under development since 2013. It has shown its value in big and small floods around the globe. While VIIRS data are excellent and critical for flood mapping, they are easily affected by clouds and cloud shadows, especially for floods caused by intensive rainfall, and thus may cause latency to flood mapping and discontinuous observations on floods. During many flood events associated with extensive clouds, it may take several days to acquire clear-sky coverage, and by then peak floods may have receded, thereby impacting the derived flood extent as it may not accurately portray the actual maximal flood.

OUTCOMES: Reduced impact from clouds and cloud shadows on VIIRS leading to improved flood mapping. Needs-driven development of flood forecasting and warning products, and improved weather forecasting products for hydrological purposes. Increased sharing of JPSS data and information at multiple levels including local.

REFERENCES

NOAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters (2018). https://www.ncdc.noaa.gov/billions/

Li, S., D. Sun, M. D. Goldberg, B. Sjoberg, D. Santek, J.P. Hoffman, M. DeWeese, P. Restrepo, S. Lindsey, and E. Holloway, 2018: Automatic near real-time flood detection using Suomi-NPP/VIIRS data. Remote Sensing of Environment, 204 (2018), 672–689.

Zheng, W., D. Sun, and S. Li, 2017: Mapping Coastal Floods Induced by Hurricane Storm Surge using ATMS Data, International Journal of Remote Sensing, 38(23), 6846-6864.

Li S., D. Sun, M. Goldberg, and W. Sjoberg, 2015: Object-based Automatic Terrain Shadow Removal from SNPP/VIIRS Flood Maps, International Journal of Remote Sensing, 36(21), 5504-5522.

Meeting Participants

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Russ Dengel	CIMSS
Jay Hoffman	CIMSS
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Dave Santek	CIMSS
Matthew Westhoff	CIMSS
Curtis Seaman	CIRA
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Jim Nelsen	NWS
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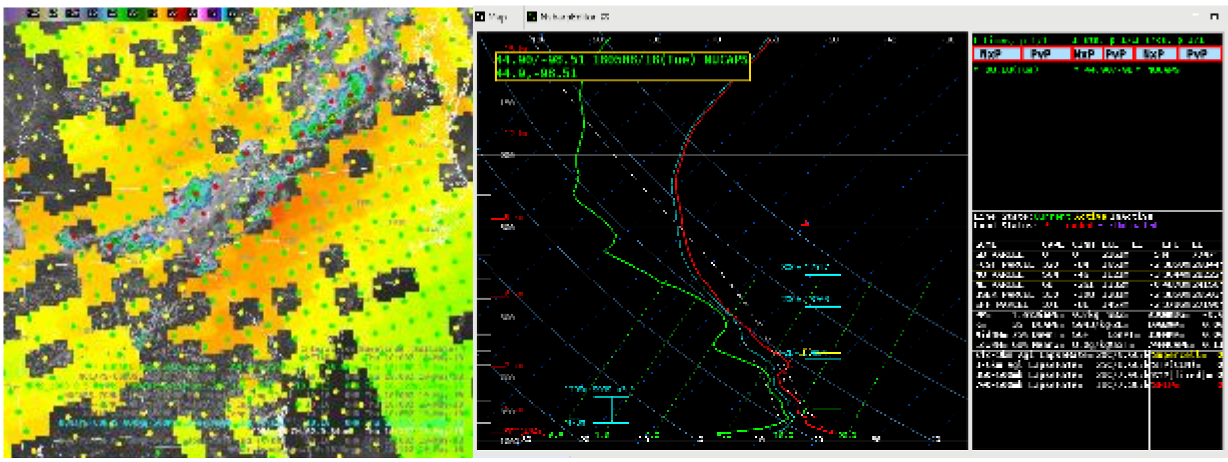
SOUNDING APPLICATIONS INITIATIVE



Operational meteorologists use NUCAPS sounding products in AWIPS-II to gain situational awareness and do quantitatively characterization of the pre-convective environment and assess the 3-dimensional extent of cold air aloft features.

MOTIVATION:

Modern sounders on polar-orbiting platforms measure vertical atmospheric temperature and humidity with high accuracy and precision. At first, measurements from these hyperspectral infrared sounders were heralded exclusively for their breakthrough impact on the quality of global numerical weather forecast models but now we see their value expanding by providing weather forecasters with up to date real-time observations of the three dimensional atmosphere. The Sounding Initiative was born in 2014 in response to the growing awareness that even though retrieved atmospheric sounding products had the potential to meet forecaster needs, they were not being used because forecasters lacked ready access to them. The Sounding Initiative thus brought together product developers and operational meteorologists to resolve this bottleneck. Now we see products from the NOAA-Unique Combined Atmospheric Processing System (NUCAPS) available within the National Weather Service AWIPS-II (Advanced Weather Interactive Processing System) and targeted information products being developed to fill data gaps. The breakthrough in establishing a knowledgeable user community and developing robust operational applications with satellite sounding products results from the fact that researchers and forecasters were given the opportunity, through the JPSS PGRR Program, to study and solve problems together. With this new cycle of funding, we look towards making the most of the NOAA enterprise architecture that provides products from four polar-orbiting platforms – Metop-A/B, Aqua, Suomi-NPP and NOAA-20 – and gives the scientific and operational communities access to measurements throughout the day and night.

WHO WE ARE

The Sounding Initiative is a community of algorithm and product developers, satellite data experts, research scientists and operational meteorologists. Sounding products observe and characterize the three dimensional atmosphere under all conditions except beneath precipitating clouds. This makes it vast in scope but difficult to characterize. Traditional validation methods do not sufficiently answer the questions meteorologists have about satellite sounding product quality in specific storm systems or forecasting scenarios. We exist as an interdisciplinary satellite community to address this shortfall.

WHAT WE DO:

We move past product validation methodologies to evaluate sounding products in real world scenarios. We choose to study the value of operational NUCAPS products in the data gaps forecasters identify. Our efforts result in an improved understanding of what the products are needed for as well as what they are good for (or where they fail), which lead us to develop new operational applications in weather forecasting and real-time decision-support systems.

Focus Areas:

- Aviation weather: the type of weather forecasting pilots need rely often on information about the mid to upper troposphere. We are serving their needs with information about cold air aloft, tropopause height and turbulence.
- Pre-convective environment: the sooner forecasters can determine, with accuracy, where and when severe storms will develop, the sooner they can issue warnings and watches. Satellite

soundings with their vertical accuracy and spatial coverage provide valuable information about atmospheric stability

- NUCAPS product quality within AWIPS-II (and other visualization tools): as a community we have access to expertise not only on the retrieval algorithm design but also the implementation and use of sounding products within AWIPS.

WHO WE WORK WITH

National Weather Service Operational scientists and meteorologists, Research scientists at Universities across the USA, NASA/SPoRT, NASA/JPS, Naval Research Laboratory, Alaskan Aviation Weather Unit, JPSS program managers, NOAA/STAR algorithm developers, validation scientists and many more.

WHEN WE MEET

We meet once a month via telecon. Over the course of four years, our Sounding Initiative telecon has become a forum for discussion of all matters related to sounding product quality and its application. It is an open meeting, and stakeholders from the broader satellite community are all invited to participate. This telecon gives an opportunity for collaboration and knowledge transfer so that everyone can share in the lessons learned.

MAJOR ACCOMPLISHMENTS

(1) Providing unique and useful data products to aviation weather forecasters. Traditionally, forecasters are used to radiosondes one at a time at 0Z and 12Z. NUCAPS now complements this traditional data source by providing forecasters with information, specifically about the mid to upper troposphere in wide swaths multiple times a day that characterizes the 3D extent of very cold air aloft, an important aviation safety concern. Prior to NUCAPS, forecasters had very limited access to observations with which they could verify models. Now NUCAPS helps them more accurately determine the onset, spatial extent, vertical depth and temporal evolution of these cold air blobs.

(2) Providing sounding products to forecasters exactly when they need it. Severe weather forecasting can be improved with access to information about the pre-convective environment, such as NUCAPS. Prior to 2018, the operational pathway of NUCAPS into AWIPS-II was too slow and saw NUCAPS soundings often available to forecasters after convective already started, which rendered them useless as attention is then set on time loops of GOES imagery and cloud products. For NUCAPS to be useful in severe weather forecasting, we had to reduce product latency. At the Hazardous Weather Testbed Spring Experiment (May 2018), we successfully demonstrated an alternative pathway into AWIPS-II that relied on NUCAPS products processed with the Community Satellite Processing Package (CSPP) from a network of direct broadcast stations across the USA. This was a major accomplishment and testimony of the strength of this initiative because we saw NUCAPS being useful to severe storm prediction for the first time because forecasters had access

to the information when they needed it. With this we demonstrated the value of satellite sounding observations in real-time decision making.

PROJECT(S):

The following section presents summaries of our projects:

- **Expanded Application and Demonstration of Gridded NUCAPS in AWIPS**
- **Improving S-NPP and JPSS-1 NUCAPS Retrievals for CONUS Severe Weather Applications via Data Fusion**
- **Merging NUCAPS with the VIIRS Enterprise Cloud Algorithms for Improved Polar Cloud Detection, Cloud Heights and Polar Winds**
- **Trajectory Model-Enhanced Nucaps Soundings For Transition Into Awips-II And Convective Initiation Forecast Skill Assessment**
- **Demonstrating, Evaluating and Promoting NUCAPS during Saharan Air Layer Events within the North Tropical Atlantic Basin**
- **Use of Direct Broadcast POESS and GOES for Localized Convective Weather Forecasting**

Expanded Application and Demonstration of Gridded NUCAPS in AWIPS

Emily Berndt, Jack Dostalek, Matt Smith, Anita Leroy, and Kevin Fuell

WHY IS THIS RESEARCH IMPORTANT?

NUCAPS vertical temperature and moisture profiles (i.e. NUCAPS soundings) are available to forecasters in AWIPS through the Satellite Broadcast Network (SBN) and have been successfully demonstrated with NWS forecasters for various forecasting challenges such as diagnosing the pre-convective environment (HWT Blog 2017), hurricane tropical to extratropical transition (Berndt and Folmer 2018), and rapid cyclogenesis. NUCAPS soundings provide high-quality thermodynamic information at off-synoptic times, between radiosonde launches. For some forecast challenges, there is an advantage to viewing the data on plan-view or cross-section displays to assess the spatial extent of the thermodynamic characteristics of the atmosphere. For this reason, a Gridded NUCAPS product was developed and assessed with the Anchorage CWSU forecasters and tested at the Hazardous Weather Testbed in 2016-2018 as a complement to vertical profiles. As Gridded NUCAPS has garnered utility and attention, with a directive from NOAA for MDL to baseline the capability, there is a need for continued deliberate collaboration between AWIPS developers, algorithm developers, scientists, and operational forecasters to ensure data quality, forecaster approval, and consistency between soundings and plan-view displays. With the addition of both NUCAPS soundings and Gridded NUCAPS in AWIPS and the availability of data from S-NPP, JPSS, MetOp-A, and –B, there is a need to explore additional applications for Gridded NUCAPS and continue to work with operational forecasters to fully realize the potential of NUCAPS in the operational environment.

GOAL: to (1) develop the best approach to implement Gridded NUCAPS in AWIPS-II, (2) ensure consistency between sounding and plan-view products, (3) explore use of microwave-only soundings and additional applications for Gridded NUCAPS, and (4) collaborate with operational forecasters and testbeds to fully realize applications of Gridded NUCAPS.

RATIONALE: The Gridded NUCAPS product was developed for the Cold Air Aloft application but proved valuable in a much wider range of forecasting scenarios. This work is in direct response to forecasters requesting specific improvements to the Gridded NUCAPS product so that they may have ready access to it.

OUTCOMES: A new NUCAPS visualization and product interrogation capability within AWIPS-II that will enable improved product access and exploitation in critical decision-making environments.

REFERENCES

Berndt, E.B. & Folmer, M. (2018): Utility of CrIS/ATMS profiles to diagnose extratropical transition. *Results in Physics,* 8: 184-185 [doi: 10.1016/j.rinp.2017.12.006].

HWT Blog (2018) “NUCAPS Posts”, The Satellite Proving Ground at the Hazardous Weather Testbed. http://goesrhwt.blogspot.com/search/label/NUCAPS.

Improving S-NPP and JPSS-1 NUCAPS Retrievals for CONUS Severe Weather Applications via Data Fusion

Jack Dostalek and John Haynes

WHY IS THIS RESEARCH IMPORTANT?

Operational radiosondes are the principal means by which forecasters receive observations concerning the vertical structure of temperature and moisture. Although unparalleled in vertical resolution, the temporal and spatial resolution of this dataset is rather limited. Balloons are launched only twice-daily, at 00 and 12 UTC. The network over the continental United States consists of 70 rather evenly spaced stations, resulting in coverage every 400 km or so. When severe weather is imminent, SPC can request that one or more stations launch an additional balloon, typically at 18 UTC, which underscores the demand that exists among severe weather forecasters to possess up-to-date knowledge concerning the vertical structure of temperature and moisture.

Two parameters derived from radiosonde observations are CIN and CAPE, which provide information on the likelihood that convection will occur, and how strong the thunderstorms will be should they develop. Variations in surface temperature and moisture, and thus variations in derived parameters such as CIN and CAPE, occur over length scales on the order of 10 km or less. This variation is much smaller than the "grid spacing" of the radiosonde network. Details concerning the temporal and spatial extent of a dangerous air mass may therefore be missed by the balloons' measurements. Additional temperature and moisture soundings, particularly those taken during the early afternoon with high spatial coverage, could improve forecasts of severe weather.

GOAL: to improve the utilization of NUCAPS sounding products in the summertime pre-convective environment of the Midwest.

RATIONALE: Forecasters depend primarily on derived instability indices for situational awareness of the pre-convective environment ahead of severe storm development. These indices are strongly dependent on accurate surface measurements. NUCAPS soundings have high uncertainty at the surface and under certain conditions exhibit a cool, dry bias. Fusion with surface observations can improve NUCAPS products and thus the instability indices forecasters depend on.

OUTCOMES: Targeted improvements in NUCAPS derived instability indices that improves the accuracy of meso-scale gradients of atmospheric instability.

REFERENCES

HWT Blog (2018) "NUCAPS Posts", The Satellite Proving Ground at the Hazardous Weather Testbed. http://goesrhwt.blogspot.com/search/label/NUCAPS.

Merging NUCAPS with the VIIRS Enterprise Cloud Algorithms for Improved Polar Cloud Detection, Cloud Heights and Polar Winds.

Andrew Heidinger and Steve Wanzong

WHY IS THIS RESEARCH IMPORTANT?

The Visible Infrared Imaging Radiometer Suite (VIIRS) is the primary sensor for providing cloud products from JPSS-1 (NOAA-20). These products are both used directly and as critical inputs to the Cross-track Infrared Sounder (CrIS) Radiance Assimilation and Polar Winds Applications. Polar regions provide bright surfaces, deep atmospheric inversions and very cold surfaces. Without absorbing IR bands, the accuracy of the VIIRS cloud detection and cloud heights suffers in Polar Regions. The cloud products from the NOAA-Unique Combined Atmospheric Processing System (NUCAPS) include cloud fraction and cloud-top pressure that are retrieved from many hyperspectral CrIS channels. The high vertical resolution of CrIS measurements offer improved accuracy in cloud-top retrievals especially over complex scenes. While the spatial resolution of NUCAPS (50km) is much coarser than VIIRS (0.75km), NUCAPS cloud-top retrievals can add new information and improve cloud products in Polar Regions.

GOAL: To improve JPSS cloud products over the Polar Regions in support of aviation and hazardous weather forecasting.

RATIONALE: The CrIS sounder contains an order of magnitude more information about cloud height than the VIIRS imager. The NUCAPS algorithm retrieves cloud parameters from high vertical resolution CrIS radiances before retrieving sounding profiles. If fused with VIIRS, NUCAPS cloud information can make an important contribution to improving operational JPSS cloud products.

OUTCOMES: Demonstrate an innovative fusion application using a NUCAPS support product, namely cloud top pressure. Verify and validate NUCAPS cloud clearing. Improve JPSS cloud products over the Polar Regions to the benefit of the Alaskan forecasting community who strongly depend on these products for aviation and winter weather forecasts.

REFERENCES

Foster, Michael. J., Heidinger, A., Hiley, M., Wanzong, S., Walther, A., and Botambekov, D. Height PATMOS-x Cloud Climate Record Trend Sensitivity to Reanalysis Products. Remote Sens. 2016, 8(5), 424; doi:10.3390/rs8050424.

Trajectory Model-Enhanced Nucaps Soundings For Transition Into Awips-II And Convective Initiation Forecast Skill Assessment

Brian Kahn, Peter Kalmus, and Emily Berndt

WHY IS THIS RESEARCH IMPORTANT?

Downward-looking satellite-based hyper-spectral infrared sounders are considered to have significant yet untapped potential to characterize the convective storm environment. While the NOAA-Unique Combined Atmospheric Processing System (NUCAPS) sounding observations from Suomi NPP, JPSS, and MetOp-A and –B each provide twice-daily snapshots in rapidly evolving convective environments, collectively speaking, they do not provide sufficient temporal resolution for forecaster needs.

GOAL: to extend a newly developed approach that uses the NOAA HYSPLIT trajectory model to evolve NUCAPS soundings in 4-D forward in time initialized at the satellite observing times of Metop-A/B, S-NPP, and NOAA-20.

RATIONALE: The GOES-16 Allsky LAP products use ABI infrared channels to derive vertical fields of temperature and moisture. These have high temporal frequency but limited vertical information and a strong dependence on model fields. Operational meteorologists have a need for observations with high vertical resolution and accuracy. The NOAA enterprise NUCAPS products are available multiple times a 24-hour day but not at regular time intervals.

OUTCOMES: Demonstrate a novel technique that adds a time dimension and regularity to high-vertical resolution satellite soundings, namely NUCAPS.

REFERENCES

Coniglio, M. C., S. M. Hitchcock, and K. H. Knopfmeier, 2016: Impact of assimilating preconvective upsonde observations on short-term forecasts of convection observed during MPEX, Mon. Wea. Rev., 144, 4301–4325

Demonstrating, Evaluating and Promoting NUCAPS during Saharan Air Layer Events within the North Tropical Atlantic Basin

Arunas P. Kuciauskas and Mayra I. Oyola

WHY IS THIS RESEARCH IMPORTANT?

The greater Caribbean region is susceptible to passages of large-scale Saharan dust outflow events, which are, more often than not, accompanied by the Saharan Air Layer (SAL). These dust aerosol plumes oftentimes significantly degrade air quality, causing severe asthma and other associated respiratory ailments (Kuciauskas, et al., 2018). The National Weather Service (NWS) in San Juan, Puerto Rico (NWS-SJU) is responsible for issuing hazardous air quality warnings to local health agencies and the general public during SAL passages. Forecasters at NWS-SJU identify the SAL events as mission critical and challenging to assess and predict, citing inadequate information within the SAL's thermodynamic structure as the system approaches their area of responsibility (AOR). This limitation is attributed in part to a sparse network of observation sites throughout the upwind tropical Atlantic; only a few rawinsonde stations exist to track the evolution of temperature and moisture fields throughout the SAL transport. Additionally, most satellite-derived products sense only bulk characteristics of the SAL structure lacking vital information regarding mineral dust concentrations and vertical profiling. Aerosol models, such as the Naval Aerosol Analysis Prediction System (NAAPS), provide useful information for dust forecasting, but improvements in the aerosol vertical characterization are still needed to fully resolve the thermodynamic aspect of the SAL.

GOAL: to demonstrate and evaluate the NOAA Unique Combined Atmospheric Processing System (NUCAPS) to support the National Weather Service (NWS) Weather Forecast Office (WFO) in San Juan, Puerto Rico (NWS-SJU) toward assessing and predicting Saharan Air Layer (SAL) events that adversely impact the Caribbean population.

RATIONALE: SAL transport is known to affect a range of weather conditions (e.g., tropical cyclone intensity) in addition to air quality. The SAL transport problem is difficult to address since it is over ocean and extends well beyond the U.S. geostationary footprint. JPSS products with their global scope are uniquely suited to characterize the thermodynamic character and aerosol load of air from the Saharan Desert.

OUTCOMES: Outreach and training of meteorologists new to the suite of JPSS sounding products. Demonstrate a novel application that combines information from multiple satellites and instruments.

REFERENCES

Kuciauskas, A., P. Xian, E. Hyer, M. Oyola, and J, Campbell: Supporting weather forecasters in predicting and monitoring Saharan Air Layer dust events as they impact the greater Caribbean, BAMS, DOI:10.1175/BAMS-D-16-0212.1, 2018

Use of Direct Broadcast POESS and GOES for Localized Convective Weather Forecasting

W. L. Smith Sr., J. Gerth, E. Weisz, and J.McNabb

WHY IS THIS RESEARCH IMPORTANT?

There are now five hyperspectral sounders (Smith et. al., 2009) in polar orbit (i.e., AIRS on Aqua, IASI on Metop-A and -B, and CrIS on S-NPP and NOAA-20). High vertical resolution (1 to 2-kms) lower tropospheric temperature and moisture profiles can be retrieved in real-time from these hyperspectral radiance data that represent the clear air columns above the ground and cloud. The vertical resolution of these profiles is sufficient for the calculation of stability parameters necessary to forecast severe weather. However, the spatial (14-km) and temporal resolution (12-hrs/satellite) can cause a failure to detect the place and onset of localized convection and storm formation.

The GOES-16 satellite carries an Advanced Baseline Imager (ABI) that is a multi-spectral channel instrument containing numerous infrared radiance water vapor channel and a lower tropospheric temperature sensitive CO2 channel. These data are available in real-time at a 2-km spatial resolution and a 15-minute temporal resolution. Although these data lack the vertical resolution needed for accurate estimates of atmospheric stability, they do have the horizontal and temporal resolution needed to observe the lower troposphere under broken clouds, as well as to pin point the location of convectively unstable air columns, and to monitor the changing stability of the atmosphere with the temporal resolution needed to predict the onset time of storm development.

GOAL: to combine real-time Hyperspectral Sounding (PHS) data with GOES-16 ABI multi-spectral radiance data to characterize the atmospheric state with improved vertical, horizontal, and temporal resolution.

RATIONALE: Data overload is a 21st century problem for operational meteorologists who are overwhelmed by thousands of measurements from different satellite platforms but lack the time to closely interrogate them all. Developers are increasingly pressed to fuse products that will reduce data volume and improve access to meaningful information.

OUTCOMES: Demonstration of an innovative technique to fuse measurements from two different satellite platforms.

REFERENCES

Smith, W. L., E. Weisz, S. Kirev, D. K. Zhou, Z. Li, and E. E. Borbas (2012), Dual-Regression Retrieval Algorithm for Real-Time Processing of Satellite Ultraspectral Radiances. J. Appl. Meteor. Clim., 51, 8, 1455-1476.

Weisz, E., Smith, W. L., and N. Smith (2013), Advances in simultaneous atmospheric profile and cloud parameter regression based retrieval from high-spectral resolution radiance measurements. J. Geophys. Res.-Atm., 118, 6433-6443.

Meeting Participants

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Lihang Zhou	STAR
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TRAINING INITIATIVE

Classroom photo showing JPSS Program Scientist, Dr. Mitch Goldberg, giving a presentation at JPSS Short Course, American Meteorological Society (AMS) Annual Meeting – 6 January, 2018, Austin, TX.

MOTIVATION:

Training for use and better understanding of current generation satellite data and products is a critical component for JPSS SNPP and NOAA-20 readiness. Users must be able to assess whether operational requirements are met and better understand new and evolving capabilities in decision support services to the Nation. The JPSS program is committed to ensuring that the satellite user community is prepared to make the most of the imagery and data available from JPSS satellites. This is accomplished through the provision of resources to help users stay engaged and up-to-date with the latest discoveries, discussions, and developments pertaining to JPSS and any affiliated satellite programs.

Satellite training is integral NOAA's satellite programs and goals, outlined in NOAA's Next Generation Strategic Plan (NGSP) (http://www.ppi.noaa.gov/ngsp/) and other planning documents. Training has been recognized as an essential ingredient in NOAA's vision for a world-class workforce to support NOAA's mission of "Science, Service, and Stewardship". Professional development and technical training enables NOAA and other agency operational practitioners to reach optimum performance in present assignments and future responsibilities. This allows for both new and experienced members of NOAA's workforce to continue to grow their skill set.

WHO WE ARE

This initiative team includes developers of training material at both University Corporation for Atmospheric Research as well as NOAA cooperative institutes including the Cooperative Institute for Research in the Atmosphere (CIRA) and Cooperative Institute for Meteorological Satellite Studies (CIMSS.) The team engages a senior user advocate from the National Weather Service Regional Scientific Services Divisions (SSD) and facilitation from JPSS Program Science and Cooperative Institute for Climate and Satellites (CICS)

WHAT WE DO:

The establishment of this new initiative allows JPSS Program Science to take an enterprise approach of both JPSS programmatic activities and PGRR Initiative projects. JPSS Program Science supports a combination of formal courses, support for minority serving institutions, as well as satellite and training liaisons to organizations throughout NOAA and outreach events. Looking across this portfolio will allow leveraging best practices. Integration of efforts also allows synergies.

JPSS base program supports formal training materials through online course work and quick guides. As part of these efforts, JPSS funds courses through the University Corporation for Atmospheric Research (UCAR) COMET program, which supports freely available online education and training modules for environmental sciences, and short courses in various national and international meetings. JPSS related COMET modules include training tutorials on GOES-R/JPSS New Generation Satellite Aerosol Products both in English and Spanish. Another example is a new COMET module on use of the JPSS River Ice and Flood Products including case studies. JPSS Quick Guides include specific descriptions of products and their utility; for example, the VIIRS Active Fire (VIIRS-AF) product Quick guide provides detections of thermal anomalies across the globe on a daily basis, including information about fire location and intensity that can be used to help in operational response decisions

Outreach includes; 1-2 day JPSS short courses at American Meteorological Society (AMS) annual meetings; networking and mentoring also at AMS events; and other activities. JPSS Program Science supports for the Students Professional and Academic Readiness with Knowledge in Satellites (SPARKS) program which focuses both as outreach to minority serving institutions and on preparation for next generation of scientists. JPSS Satellite Liaisons connect satellite algorithm developers, trainers, and forecasters, steering and focusing the research and training directions to best serve operational needs. Finally JPSS supports programs at NOAA Cooperative Institutes at NASA which also focus on education and outreach.

Focus Areas:

- International Outreach through commitment to the Coordination Group for Meteorological Satellites: Enhancing the International Virtual Laboratory (VLaB)
- Development of training videos for NOAA-20 and SNPP for National Weather Service Forecast Offices
- Integration of JPSS education, training and outreach activities within JPSS Program Science and within NOAA where relevant.

WHO WE WORK WITH

Training projects teams work with weather forecasters from the NWS and the international community; emergency managers – national and international; World Meteorological Organization's Coordination Group for Meteorological Satellites (CGMS); NWS Office of the Chief Learning Officer and NWS international training desks.

WHEN WE MEET

Meetings will be held quarterly**.** Each quarterly meeting focuses on individual projects. Principal investigators will present their results and get feedback from stakeholders and other team members.

MAJOR ACCOMPLISHMENTS:

This is a new initiative at the beginning of the 2018-2021 period of performance. This initiative builds upon the foundation of the established International Vlab training efforts, NOAA GOES training efforts, JPSS training and outreach efforts and the COMET program's long history of success.

PROJECT(S):

For the FY 2018-2021 period of performance projects supported include: the training international outreach through the provision of courses and regular engagement of partners; and the development of training materials for National Weather Service forecasters. Insights and outcomes from these projects will in time become part of JPSS training capabilities.

The following section presents summaries of our projects in addition to the core support and satellite training liaisons:

- **The JPSS Advocacy Channel**
- **International Virtual Lab Training Activities**

The JPSS Advocacy Channel

Scott Lindstrom, Lee Cronce, William Straka and Jordan Gerth

WHY IS THIS RESEARCH IMPORTANT?

Widespread use of satellite data from polar orbiting satellites is impeded by a variety of factors.

The National Weather Service has an awareness and knowledge challenge with respect to JPSS use in the field. Forecasters in general are not aware of the unique channels (and derived products) that are available from POES and JPSS, and they need guidance on how to use these bands and how to incorporate them into their workflow.

GOAL: to create short and compelling training videos for NOAA-20/Suomi NPP and future JPSS platforms, and other relevant polar orbiting satellites to spur increased use of Polar Operational Environmental Satellite (POES) data in National Weather Service Forecast Offices (and elsewhere). The channel will serve as a repository for short training videos.

RATIONALE: Videos can be memorable and engaging. When of suitable length, they are easily digestible. They can show interesting cases in a short time so that forecasters – and others – can learn the easiest way to use JPSS data. Videos are readily accessible, and retention is made simple: just re-watch the video. Videos allow for knowledge retention and will make learning stick. Easily-available videos can also be an important training source for non-forecasters, such as Fire Weather specialists who should be interested in JPSS-derived products. Importantly, we hope that videos will feature NWS forecasters and actual forecast challenges helped by POES/JPSS data, to foster peer-to-peer training.

OUTCOMES: Increased exposure to JPSS-derived products

REFERENCES

Schmit, T. J., S. S. Lindstrom, J. J. Gerth and M. M. Gunshor, 2018: Operational Applications of the 16 Spectral Bands on the Advanced Baseline Imager (ABI). *J. Operational Meteor.* (***Accepted, in revision***)

Schmit, T. J., S. J. Goodman, M. M. Gunshor, J. Sieglaff, A. K. Heidinger, A. S. Bachmeier, S. S. Lindstrom, A. Terborg, J. Feltz, K. Bah, S. Rudlosky, D. T. Lindsey, R. M. Rabin and C. C. Schmidt: Rapid Refresh Information of Significant Events: Preparing users for the next generation of geostationary operational satellites, 2014. Bulletin of the American Meteorological Society

International Virtual Lab Training Activities

Bernadette Connell

WHY IS THIS RESEARCH IMPORTANT?

NOAA's Engagement Enterprise Objective strives to promote "Full and effective use of international partnerships and policy leadership to achieve NOAA's mission objectives". Relevant to this proposal, NOAA already supports active engagement of partnerships by being a member of the World Meteorological Organization, being a contributing member of the WMO Coordination Group for Meteorological Satellites (CGMS) and being a contributing member to the WMO Virtual Laboratory for Education and Training in Satellite Meteorology (VLab).

GOAL: Leverage NWS' NCEP"S International Desks to continue to provide regular virtual monthly Regional Focus Group Sessions. Part of the goals of this project is also to develop and deliver materials and instructions for in-person training events, and will expand efforts related to the GEONETCast-Americas data broadcast.

RATIONALE: The intensive in-person contact with international users followed up with regular online engagement afterward is an ideal way to build capacity. In dealing with participants, common issues encountered include having low-cost access to real-time imagery, knowing where to get archive imagery, having a low-cost option to display imagery and products, and knowing how to use the software and interpret the product. This project leverages existing training of and for GEONETCast including interacting with the user community to assess needs and delivering training to address the gaps.

OUTCOMES: Improved utilisation of JPSS data and products in the international community as well as capacity building in the international community.

REFERENCES

Brown, P. C., H. L. Roediger, III, and M. A. McDaniel, 2014: "Make It Stick: The Science of Successful Learning" Harvard University Press.

Purdom, J., 1997: Satellite Meteorology Applications: A Demonstration Project for Regional Meteorological Training Centers. WMO Bulletin, 46(3), pages 230-237.

VOLCANIC HAZARDS INITIATIVE

An image of a volcanic ash plume from Pavlof Volcano in Alaska was taken by astronauts onboard the International Space Station on May 18, 2013 (credit: NASA). As the image illustrates, volcanic clouds are generally very complex.

MOTIVATION:

Volcanic eruptions are one of the most spectacular natural phenomena, capable of altering global climate and producing an array of hazards. Volcanoes frequently generate clouds of ash and sulfur dioxide that have far reaching impacts, particularly on aviation. Aircraft encounters with ash clouds can diminish visibility, damage flight control systems, and cause jet engines to fail. Sulfur dioxide (SO2) and a sulfur dioxide byproduct, sulfate aerosol, are also aviation hazards. Aircraft passengers and crew exposed to SO2 and sulfate aerosol may experience irritation of the skin, eyes, nose, and throat. Volcanic ash and SO2 are a global aviation hazard because atmospheric winds often transport ash and SO2 great distances from the source volcano. Disruption to aviation is not the only far reaching impact of volcanic eruptions. Climate altering eruptions inject large amounts of sulfur dioxide high into the atmosphere. The sulfur dioxide layer gradually transforms into a layer of sulfate aerosol that diminishes the amount of sunlight reaching the earth's surface, which can temporarily cool the planet and alter weather patterns. Closer to the source volcano, ashfall, heated debris flows, lava flows, and poor air quality are common hazards. Even smaller eruptive events, which occur on a daily basis, can impact local populations and aviation. Given these various hazards and impacts, routine operational monitoring of volcanoes and volcano byproducts, such as ash and SO2 clouds, is critical. As such, the United States Geological Survey (USGS) routinely monitors volcanoes in the United States and beyond and NOAA operates Volcanic Ash Advisory Centers that track hazardous volcanic clouds 24/7.

The purpose of the new PGRR volcanic hazard initiative is to ensure that JPSS measurements, in combination with other relevant data, are being fully utilized for volcanic hazard applications.

WHO WE ARE

The initiative team consists of scientists at Office of Oceanic and Atmospheric Research Air Resources Laboratory, NESDIS / Center for Satellite Applications and Research, Michigan Technological University, the University of Alaska - Fairbanks, the NOAA Cooperative Institute for Meteorological Satellite Studies, and the United States Geological Survey.

WHAT WE DO:

The initiative team develops multi-sensor products for volcanic hazard applications such as volcanic cloud detection, tracking, and forecasting. The development team works closely with operational partners to introduce new capabilities into operations and further improve those capabilities. This initiative is also, in part, responding to the aviation industry request for more detailed information on ash and SO2 clouds needed to help mitigate safety and economic risks. In short, we transform JPSS measurements into actionable information for volcanic hazard applications.

Focus Areas:

- Development and improvement of satellite-derived volcanic ash and sulfur dioxide (SO2) products and monitoring tools, including multi-sensor products

- Automated ingestion of satellite-derived information into models that forecast the dispersion and transport of volcanic ash and SO2 in the atmosphere
- End user evaluations

WHO WE WORK WITH

The research team works closely with operational partners at Volcanic Ash Advisory Centers, Meteorological Watch Offices, and United States Geological Survey Volcano Observatories. We also interact with international partners at Volcanic Ash Advisory Centers and Volcano Observatories. In addition, research team members routinely interact with stakeholders at airlines, the U.S. Department of Defense, and the International Civil Aviation Organization.

WHEN WE MEET

The development team will meet monthly to track project milestones and identify issues that may require assistance from JPSS-PGRR management. Quarterly meetings will also be held with a wider group that includes operational partners and JPSS management staff to provide progress reports, guidance on real-time demonstrations and user feedback.

MAJOR ACCOMPLISHMENTS

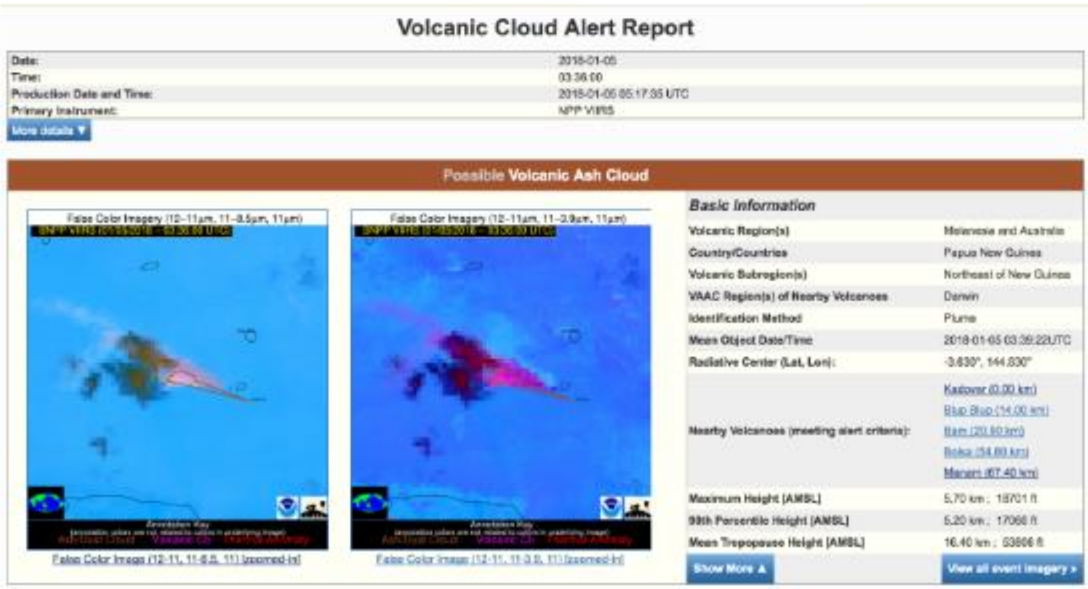
The new initiative builds upon previous JPSS PGRR and GOES-R Risk Reduction research aimed at using multiple sensors to detect and characterize volcanic ash and SO2, through continued development of the VOLcanic Cloud Analysis Toolkit (VOLCAT) and NOAA's operational dispersion model, HYSPLIT. The initiative, however, is in its early stages so there are no major accomplishments to report at this time.

PROJECT(S):

The following section presents a summary of our project "**A JPSS Initiative for Improving Volcanic Hazard Monitoring and Forecasting**".

A JPSS Initiative for Improving Volcanic Hazard Monitoring and Forecasting

Michael J. Pavolonis (PI - NOAA/NESDIS/STAR), Simon Carn (Michigan Tech), Alice Crawford (UM-CICS), Christoph Kern (USGS), Jamie Kibler (NOAA/NESDIS/SAB), Taryn Lopez (UAF), Christina Neal (USGS), Jeff Osiensky (NWS), Dave Schneider (USGS), Ariel Stein (NOAA/OAR/ARL), Bill Ward (NWS)



A VOLCAT volcanic eruption alert report, derived from a Suomi NPP overpass on January 5, 2018 at 03:39 UTC, is shown. The alert captured the first known eruptive activity at Kadovar volcano in Papua New Guinea.

This initiative builds upon previous JPSS PGRR and GOES-R Risk Reduction research aimed at using multiple satellite sensors to detect and characterize volcanic ash and sulfur dioxide (SO_2) within the VOLcanic Cloud Analysis Toolkit (VOLCAT) developed by NOAA and collaborators at the University of Wisconsin-Madison. Initial focus will be on validating and optimizing the multi-sensor JPSS volcanic ash and SO2 products, from Suomi NPP and NOAA-20, for use in NOAA's operational dispersion model, HYSPLIT.

GOAL: To fully exploit the JPSS measurements for user driven volcano applications through the creation of a new initiative. The initiative, which was first motivated in the 2016 JPSS Program Science Digest, will help accelerate improvements to operational capabilities while advancing volcano science (e.g. improved knowledge of one of the most powerful naturally occurring phenomena on earth). As a starting point, it will focus on improving many aspects of volcanic cloud detection, tracking, characterization, and forecasting. Volcanic clouds contain one or more hazardous constituents, such as volcanic ash and sulfur dioxide (SO_2). Some collateral benefits may include improved dust and industrial SO_2 monitoring, since these features share some attributes of volcanic clouds (volcanic clouds are especially complicated and require a special focus). The volcanic cloud problem is unique in that the operational community often consults with the research community during volcanic crises.

RATIONALE: NOAA operates two out of nine of the world's Volcanic Ash Advisory Centers (VAAC's) and three Meteorological Watch Offices (MWO). NOAA's VAAC's and MWO's are responsible for issuing operational products, related to volcanic clouds, for a huge area that spans from the Western Pacific to the Central Atlantic and from Alaska to South America.

NOAA works closely with the USGS Volcano Hazards Program (VHP) on matters related to volcanic clouds. The USGS VHP mission is to enhance public safety and minimize social and economic disruptions from eruptions through delivery of effective forecasts, warnings, and information on volcano hazards based on scientific understanding of volcanic processes. Meteorological satellites are one of the data sources utilized by the USGS in support their mission. The U.S. Department of Defense also has an operational need for global volcanic cloud monitoring. The global coverage of JPSS measurements, combined with the advanced multi-sensor capabilities, makes JPSS an extremely valuable asset for volcanic cloud applications.

OUTCOMES: Improved volcanic hazard monitoring and forecasting at NOAA's Volcanic Ash Advisory Centers (VAAC's), the NWS Pacific Region, the USGS, and other operational centers (e.g. DoD, international VAAC's and volcano observatories).

Improved volcanic cloud analysis and forecasting capabilities, including for volcanic fog (vog) applications.

REFERENCES

Carn, S. A., L. Clarisse, and A. J. Prata (2016), Multi-decadal satellite measurements of global volcanic degassing, Journal of Volcanology and Geothermal Research, 311, 99-134, doi:10.1016/j.jvolgeores.2016.01.002.

Chai, T. F., A. Crawford, B. Stunder, M. J. Pavolonis, R. Draxler, and A. Stein (2017), Improving volcanic ash predictions with the HYSPLIT dispersion model by assimilating MODIS satellite retrievals, Atmospheric Chemistry and Physics, 17(4), 2865-2879, doi:10.5194/acp-17-2865- 2017.

Guffanti, M., T. J. Casadevall, and K. Budding (2010), Encounters of aircraft with volcanic ash cloud; A compilation of known incidents, 1953-2009, in U.S. Geological Survey Data Series, edited by USGS, http://pubs.usgs.gov/ds/545.

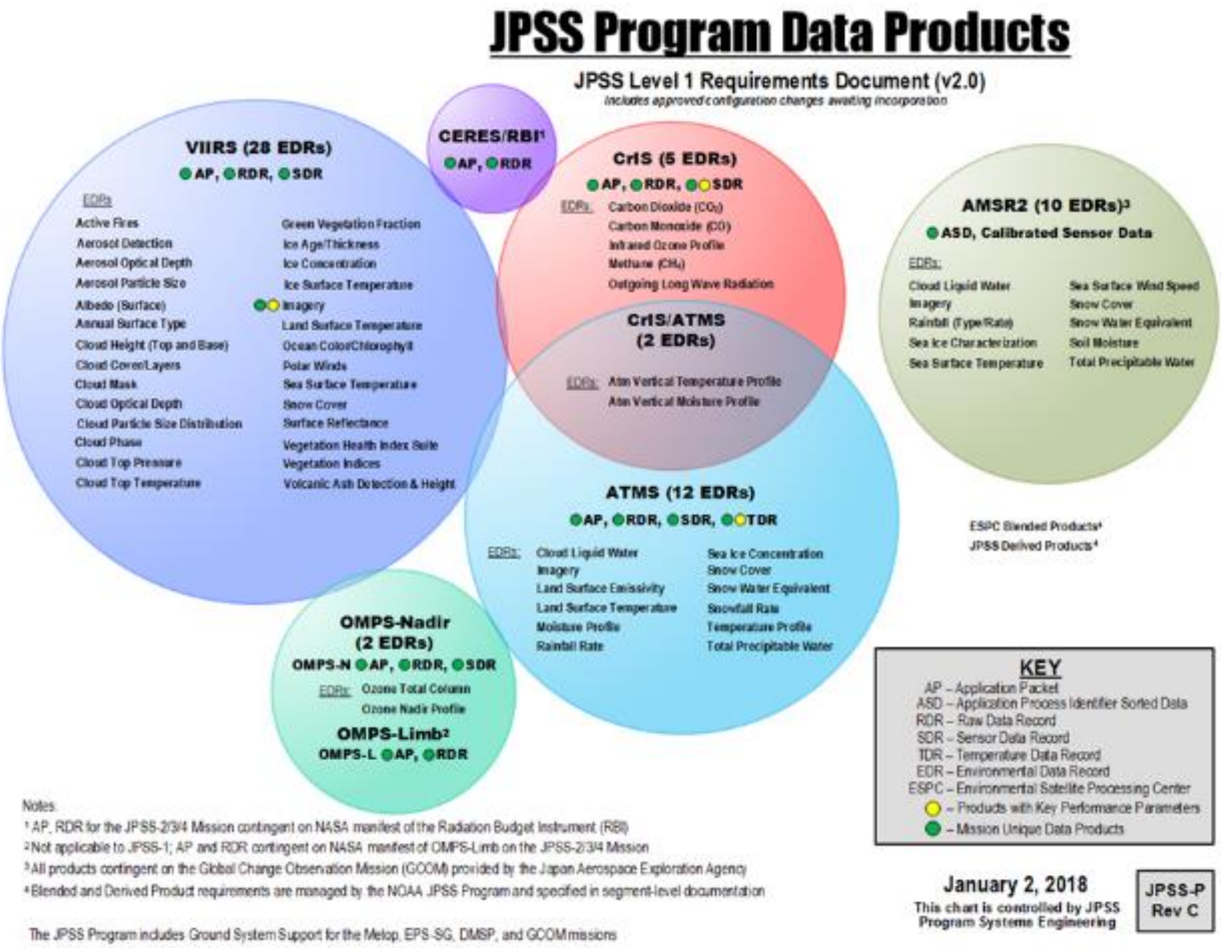
Pavolonis, M., A. Heidinger, and J. Sieglaff (2013), Automated retrievals of volcanic ash and dust cloud properties from upwelling infrared measurements, Journal of Geophysical Research Atmospheres, 118(3), 1436-1458, doi:10.1002/jgrd.50173.

Pavolonis, M. J., J. Sieglaff, and J. Cintineo (2015b), Spectrally Enhanced Cloud Objects: A generalized framework for automated detection of volcanic ash and dust clouds using passive satellite measurements: 2. Cloud object analysis and global application, Journal of Geophysical Research-Atmospheres, 120(15), 7842-7870, doi:10.1002/2014jd022969.

INNOVATION

**Innovation is a special category of projects under the PGRR Program. Innovation encompasses "out-of-the-box" ideas and concepts. It is the JPSS response to NOAA's broad and comprehensive mission, which evolves with society's rapidly changing demand for environmental intelligence.*

INNOVATION



The above chart show the full suite of JPSS Environmental Data Record and Sensor Data Record (SDR) currently operational or in development.

MOTIVATION:

Innovation is critical to keeping NOAA cutting edge and ensuring adaptability and long-term success. The information content from Suomi NPP and NOAA-20 sensors holds the potential to develop new applications that were not envisioned as part of the original scope. The constellation of the two satellites and the established data record of SNPP, allows for synergies with other sensors to include gap filling and blending. Other science, engineering and technological advances inspire and enable new directions for JPSS and NOAA. Organizational change, within and outside of NOAA, encourages JPSS to invest in new ways of interacting with diverse partners from academia, international organization and emergency management.

WHO WE ARE:

The Innovation area includes seven separate projects. Principal investigators include scientists from the NOAA Cooperative Institutes such as Cooperative Institute for Meteorological Satellite Studies at University of Wisconsin, Cooperative Institute for Research in the Atmosphere at Colorado State, and Cooperative Institute for Climate and Satellites at University of Maryland. Investigators also come from NOAA offices such as the Air Resources Laboratory and Center for Satellite Applications and Research.

WHAT WE DO:

The JPSS PGRR Innovation area is designed to uncover and cultivate new ideas, methods, and ways of doing things. As with all PGRR initiatives and projects, innovations projects must demonstrate societal benefit.

Objectives:

For the FY 2018 to FY 2021 period of performance, innovation includes both new and novel applications of JPSS data and products. A risk reduction is addressed through new product development. Also included is ensuring that JPSS data can be well characterized beyond calibration and validations activities, by development of climate data records.

Focus Areas:

- New product development or enhancements
- Applications for JPSS products in forecaster applications to include dispersion modeling
- Testbed activities that accelerate transition to operations
- Development of Climate Data Records (CDR)

PROJECT(S):

The following section presents summaries of our projects:

- **Maximizing CICS-MD Contributions to the JPSS Proving Ground Initiative**

- **Visible Applications in Dark Environments, Revisited (VADER): NOAA-20 Joins S-NPP on the "Dark-Side" to Empower Day/Night Band Research and Operational Capabilities**
- **Development and Impact of Global Winds from Tandem S-NPP and NOAA-20 VIIRS**
- **Exploiting VIIRS Multispectral Imaging to Support Hazard Detection, Nowcasting, and JPSS PGRR Initiatives for the Benefit of Forecasters and Stakeholders**
- **Improving NOAA operational forecasts of Dust Weather Hazards through assimilating JPSS aerosols and land products (AOD, Dust Mask, and Albedo)**
- **Concept Study to Extend VIIRS Spectral Coverage Using CrIS Radiance Measurements and to Explore Potential Applications**
- **Extending the Atmospheric Temperature Climate Data Record from POES Microwave/Infrared Sounders to JPSS/ATMS/CrIS**

Maximizing CICS-MD Contributions to the JPSS Proving Ground Initiative

E. Hugo Berbery and Scott Rudlosky

WHY IS THIS RESEARCH IMPORTANT?

Focused satellite proving ground efforts are required to ensure smooth operational transitions of experimental JPSS products. Many NESDIS/STAR scientists develop algorithms that have a variety of operational applications. These products and applications benefit from direct interactions between scientists and forecasters. NESDIS/STAR/CoRP Cooperative Institutes (CIs) are the primary vehicles for developing and implementing operational satellite products into the National Weather Service (NWS) forecast environment. The CICS in College Park, MD has capabilities for creating and integrating new products into the NWS Advanced Weather Interactive Processing System (AWIPS) software, and facilities to host forecasters for satellite product demonstrations.

GOAL: To help bridge the gap between scientists, forecasters, and project managers to reduce the barriers to new product development and integration.

RATIONALE: Focused satellite proving ground efforts are required to ensure smooth operational transitions of experimental JPSS products. With new satellites in both geostationary and low-earth orbit, there has to be an established framework in place to ensure that satellite science and technology does not run the risk of outpacing the development of new NWS requirements.

OUTCOMES: Streamlined transition of JPSS funded products into NWS operations.

Visible Applications in Dark Environments, Revisited (VADER): NOAA-20 Joins S-NPP on the 'Dark-Side' to Empower Day/Night Band Research and Operational Capabilities

Steven Miller, William Straka, III, Curtis Seaman, Yoo-Jeong Noh, Louie Grasso, Jeremy Solbrig, and Cindy Combs

WHY IS THIS RESEARCH IMPORTANT?

Visible light satellite imagery and the many environmental applications that it touches are indispensable to daytime operational weather forecasting. In contrast to conventional infrared data, visible imagery provides myriad benefits to scene characterization and environmental awareness, including: superior scene contrast for maritime clouds, the ability to see through overriding cirrus to reveal underlying low clouds/fog, superior and in some cases the unique ability to detect atmospheric aerosol (e.g., smoke, pollution, dust, volcanic ash), better identification of low-level circulation cloud patterns in the transitional phases of tropical storms, detection of snow cover, lake ice, and sea ice, all at higher spatial resolution than what infrared bands can offer collectively. What's more, well-calibrated visible light imagery offers the further ability to quantify the optical properties of cloud and aerosol to an extent that infrared imagery cannot, making the measurements useful for a variety of aviation-centric applications as well as basic research on the dynamics of the coupled earth/atmosphere system, and extending beyond the space/time scales of weather forecasting into the circles of global climatology.

GOAL: the project team will interface with the NOAA user community to help demonstrate the utility of low-light visible imagery, explain its content, and advocate for the development of "low-light visible thinking" within the nocturnal forecasting protocol.

RATIONALE: The novelty and unconventional nature of low-light visible requires a careful and thorough approach to its presentation. Signals related to lunar glint off water surfaces, city light diffusion through clouds, lightning flashes, meteor streaks, active fire lines, and nightglow gravity waves are among the features requiring user familiarization. Once the physical basis for these features and how they manifest in DNB imagery are understood, they transition from potentially confusing distractions/artifacts to potentially useful sources of additional information on the current state of the atmosphere/surface.

OUTCOMES: Ability to detect and characterize nighttime and low light environmental changes, such as ship motion or power outages and other activities.

REFERENCES

Miller, S. D., W. C. Straka, III, J. Yue, C. J. Seaman, S. Xu, C. D. Elvidge, L. Hoffman, S. I. Azeem, 2017: The Dark Side of Hurricane Matthew—Unique Perspectives from the Day/Night Band. Submitted to Bull. Amer. Meteor. Soc.

Miller, S. D., 2015: Night Watch. A satellite sensor that can see in the dark is revealing new information for meteorologists, firefighters, search teams and researchers worldwide. Sci. American, 312(5), 78-81.

Seaman, C. J. and S. D. Miller (2015): A dynamic scaling algorithm for the optimized digital display of VIIRS Day/Night Band imagery. International Journal of Remote Sensing, 36 [7], 1839-1854

Development and Impact of Global Winds from Tandem S-NPP and NOAA-20 VIIRS

Jeffrey Key, David Santek, and Jaime Daniels

WHY IS THIS RESEARCH IMPORTANT?

Wind information over the Polar Regions has been generated with data from the Moderate Resolution Imaging Spectroradiometer (MODIS) instrument on NASA's Terra and Aqua satellites and the Advanced Very High Resolution Radiometer (AVHRR) on NOAA satellites since 2001. A polar winds product based on the Visible Infrared Imager Radiometer Suite (VIIRS) instrument on the Suomi National Polar-orbiting Partnership (S-NPP) satellite became operational at NOAA in 2014.

The VIIRS, MODIS, and AVHRR polar winds products provide wind speed, direction, and height wherever there is a high-quality cloud or water vapor (for MODIS only) feature that can be tracked in a sequence of three orbits with a total time between the first and last of the triplet of approximately 200 minutes. Because the region of overlap in the three orbits is used for tracking, coverage is limited to an area poleward of approximately 65 degrees latitude. An example of the single-satellite VIIRS winds is given in Figure 1. Combining satellites, even polar-orbiting and geostationary, has proven useful, extending the high-latitude coverage equatorward somewhat (Lazzara et al., 2013).

GOAL: To develop a unique global wind product from NOAA-20/Suomi NPP tandem and to test its impact on numerical weather prediction. And, to extend this product and the single-satellite VIIRS polar winds by adding a shortwave infrared (SWIR) band at 2.25 µm and the day-night band (DNB).

RATIONALE: Method will result in higher quality upper air winds with reduced product latency than the current 100-minute latency for polar winds. Additionally, method allows for global coverage rather than being limited to high latitude coverage.

OUTCOMES: Routinely generated, near-operational, NOAA-20/S-NPP dual winds with assessment of their impact on numerical weather prediction. Additionally the longer term outcomes will be higher skill in weather forecast guidance.

REFERENCES

Bresky, W., J. Daniels, A. Bailey, and S. Wanzong, 2012, New Methods Towards Minimizing the Slow Speed Bias Associated with Atmospheric Motion Vectors (AMVs). J. Appl. Meteor. Climatol., 51,2137-2151.

Daniels, J., W. Bresky, J. Key, S. Wanzong, and A. Bailey, 2014, NOAA VIIRS Polar Winds Product System (NVPWPS) Algorithm Theoretical Basis Document, Version 1.0, NOAA/NESDIS/OSPO, June 18, 2014, 73 pp.

Velden, C.S., C.M. Hayden, S.J. Nieman, W.P. Menzel, S. Wanzong, and J.S. Goerss, 1997, Upper-tropospheric winds derived from geostationary satellite water vapor observations. Bull. Amer. Meteorol. Soc., 78(2), 173-196.

Exploiting VIIRS Multispectral Imaging to Support Hazard Detection, Nowcasting, and JPSS PGRR Initiatives for the Benefit of Forecasters and Stakeholders

Curtis J. Seaman, and Steven D. Miller

WHY IS THIS RESEARCH IMPORTANT?

For operational users, decision making is often accompanied by a vast amount of data to sort through and a limited amount of time. Many lack the time to consider the vast amounts of weather data (in this case, all 22 spectral bands on VIIRS) that are available. As a result, when presenting satellite data to operational users and conveying the current state of the weather to the public, these time demands must be considered. Satellite imagery has been used to help identify atmospheric features, understand atmospheric processes, enhance forecaster decision-making, and communicate reliable information of the actual weather situations. It is an essential part of forecast operations. Multispectral imagery techniques (including RGB composites) combine information from various channels to highlight hazards or present an intuitive view of the current state of the land/ocean/atmosphere system that increases situational awareness and facilitates decision making.

GOAL: To develop new and improve upon old multispectral VIIRS imagery products based on NWS forecaster interactions (including National Centers and River Forecast Centers); and to demonstrate and distribute these algorithms/ products and associated training materials to the user community.

RATIONALE: Multispectral imagery techniques (including RGB composites) combine information from various channels to highlight hazards or present an intuitive view of the current state of the land/ocean/atmosphere system that increases situational awareness and facilitates decision making. Multispectral imagery products specifically designed for VIIRS have been produced since 2011 when it launched aboard the Suomi NPP satellite. Although many of the value-added VIIRS imagery applications have featured prominently in the JPSS proving ground, many forecasters have not benefited from these applications in their native AWIPS/NAWIPS and non-AWIPS environments. This is in part because many operational users outside the National Weather Service are unable to access AWIPS.

OUTCOMES: An assortment of value-added VIIRS imagery products that will be made available to AWIPS/NAWIPS systems for the first time. Streamlined use of VIIRS multispectral products

REFERENCES

d'Entremont, R. P., and L. W. Thomason (1987): Interpreting meteorological satellite images using a color-composite technique. BAMS, 68(7), 762-768.

EUMETSAT (2009): Best practices for RGB compositing of multi-spectral imagery. User Services Division, 8 pp. [Available online at http://oiswww.eumetsat.int/idds/html/doc/best_practices.pdf].

Miller, S. D., T. L. Schmit, C. J. Seaman, D. T. Lindsey, M. M. Gunshor, R. A. Kohrs, Y. Sumida, and D. Hillger (2016): A sight for sore eyes -The return of true color to geostationary satellites. BAMS, 97(10), 1803-1816.

Improving NOAA operational forecasts of Dust Weather Hazards through assimilating JPSS aerosols and land products (AOD, Dust Mask, and Albedo)

Daniel Q. Tong, Andy Edman, Ariel Stein, Shobha Kondragunta, Yunyue Yu, and Pius Lee

WHY IS THIS RESEARCH IMPORTANT?

Dust storms are one of the deadliest weather hazards, with a death toll exceeded only by heat wave and flooding in some western states. While dust storms do not fit the conventional description of severe weather, they can have a variety of societal and environmental impacts. Dust storms disrupt air and highway transportation, impose threats to human health (heart attack, asthmas, Valley fever, etc.), and reduce solar and agricultural productivity, imposing increasing economic burden on local communities.

The dust models currently used by the National Weather Service (NWS) often fail to capture the most dangerous "killer" dust storms. As the result the NWS has highlighted pressing needs to address improvements in dust weather forecasting, which aligns with NOAA's core mission to "build a Weather-Ready Nation and to mitigate human life and property loss from weather hazards".

GOAL: To improve NWS operational forecasts of dust weather hazards through newly developed emission data assimilation with JPSS aerosol and land products.

RATIONALE: As droughts have become more frequent and severe in the western states, the number of high-impact dust storms is fast rising (Hand et al., 2016; Tong et al., 2017). Thus, provision of reliable forecasting to reduce life and economic losses from dust weather hazards is an absolute necessity. Despite recent progress, the NWS National Air Quality Forecast Capability (NAQFC) dust forecasts often fail to capture life-threatening dust storms. For instance, in 2015, high-impact dust storms caused more than 35 traffic accidents and six related deaths in the United States. While the NAQFC successfully predicted the April 14 dust storm, which claimed three lives over the Western U.S., it failed to capture the other smaller storms.

Similarly, among the four highway accidents that killed 10 people in Lordsburg, NM, in 2017, NAQFC failed to capture all of these "killer storms." These smaller dust storms are usually formed quickly and are more difficult for motorcyclists to cope with due to shorter response time, leading to disproportionately higher life and property losses. Currently, NAQFC dust forecasts are unable to meet the demands of these decision-making users in preparing proper early warnings to save lives and prevent property losses.

OUTCOMES: Improved dust predictive capability for the NWS to include improved sub-seasonal to long-term dust simulations in order to reduce injuries, human life and property losses in the United States.

REFERENCES

Tong, D. Q., J. X. L. Wang, T. E. Gill, H. Lei, and B. Wang (2017), Intensified dust storm activity and Valley fever infection in the southwestern United States, Geophys. Res. Lett., 44, doi:10.1002/2017

Huang, Min, D. Tong, P. Lee, L. Pan, Y. Tang, I. Stajner, R. B. Pierce, J. McQueen, and J. Wang. "Toward enhanced capability for detecting and predicting dust events in the western United States: the Arizona case study." Atmospheric Chemistry and Physics 15, no. 21 (2015): 12595-12610

A. F. Stein, R. R. Draxler, G. D. Rolph, B. J. B. Stunder, and M. D. Cohen and F. Nagan, “NOAA’s HYSPLIT Atmospheric Transport and Dispersion Modeling System” in BAMS, 96 2059-2077

Lee, P., McQueen, J., Stajner, I., Huang, J., Pan, L., Tong, D., Kim, H., Tang, Y., Shafran, P., Huang, H.-C., Gorline, J., Upadhayay, S., and Artz, R., 2017: NAQFC developmental forecast guidance for fine particulate matter (PM2.5), Weather and Forecasting, 32 no.1. pp 343-360

Concept Study to Extend VIIRS Spectral Coverage Using CrIS Radiance Measurements and to Explore Potential Applications

Elisabeth Weisz, Eva Borbas, and W. Paul Menzel

WHY IS THIS RESEARCH IMPORTANT?

Polar-orbiting weather satellite platforms include both a high spatial resolution imager, and a high spectral resolution (or hyperspectral) infrared (IR) sounder. The imagers are designed to take measurements for a limited set of narrow wavelength bands at visible through IR wavelengths. The imager data are used, for example, to develop operational aerosol, moisture, and cloud properties. The sounder measurements are used generally to infer profiles at high vertical resolution of temperature, water vapor, and ozone and also to infer surface, trace gas, and cloud properties.

However, there are differences in the satellite imager/sounder measurements across platforms. Some imagers (e.g. AVHRR, VIIRS) lack absorbing IR bands that are necessary to obtain accurate products such as total column precipitable water vapor and cloud properties (e.g., cloud top height, thermodynamic cloud phase). These differences make it extremely challenging to develop consistent atmospheric products that can be utilized across multiple platforms.

GOAL: To develop a data fusion methodology based on imager-sounder pairs to construct the missing IR absorption bands, which then can enable the derivation of more consistent atmospheric products.

RATIONALE: The fusion of imager/sounder pairs offers new opportunities for retrieving accurate atmospheric and surface products and for studying their impact on operational and research applications.

OUTCOMES: (1) improved cloud top heights and cloud thermodynamic phase, (2) high spatial resolution total precipitable water (TPW) (3) improved volcanic ash characterization especially heights (4) polar winds using the fusion-based H_2O spectral bands

REFERENCES

Cross, J. I.,I. Gladkova, W. P. Menzel, A. Heidinger, and M. D. Grossberg(2013), Statistical estimation of a 13.3 µm Visible Infrared Imaging Radiometer Suite channel using multisensor data fusion, J. Appl. Remote Sens.7 (1), 073473 (2013)

Weisz, E., B. Baum and W. P. Menzel (2017),Fusion of satellite-based imager and sounder data to construct supplementary high spatial resolution narrowband IR radiances, J. of Applied Remote Sensing, Volume 11, Issue 3, 2017

Extending the Atmospheric Temperature Climate Data Record from POES Microwave/Infrared Sounders to JPSS/ATMS/CrIS

Cheng-Zhi Zou, and Qiang Fu

WHY IS THIS RESEARCH IMPORTANT?

Atmospheric temperature is one of the key variables used to determine the current states of weather and climate and long-term changes. Satellite-borne sensors are the only means available for providing global atmospheric temperature observations. These measurements have been obtained from instruments such at the MSU (1979 – 2006) on board the NOAA TIROS-N POES series, the AMSU-A on board the NOAA-KLM series, NASA Aqua, and European MetOp series, and new generation microwave sounders such as the Advanced Technology Microwave Sounder (ATMS) being flown on the Suomi National Polar-orbiting Partnership (Suomi NPP) and the NOAA-20 (JPSS-1 prior to launch). While AMSU-A measurements are not high enough to completely cover the upper-stratospheric layers, hyperspectral infrared sounders starting from 2002, including NASA EOS Atmospheric Infrared Sounder (AIRS), MetOp Infrared Atmospheric Sounding Interferometer (IASI), and SNPP/JPSS Cross-track Infrared Sounder (CrIS) contain sufficient channels to measure temperatures in this layer. While designed primarily for weather observations, due to their continuity and global coverage, these instruments are the basis for an indispensable long-term and high quality global climate data record (CDR) in support of the climate research communities as well as service providers and users to monitor historical atmospheric temperature changes.

GOAL: To extend the current STAR MSU/AMSU-A deep-layer atmospheric temperature CDR to the SNPP/JPSS ATMS, allowing the climate change monitoring from 1979 to the JPSS era. And, to investigate merging approaches that will enable the extension of SSU observations to the hyperspectral sounders AIRS/CrIS.

RATIONALE: In homogenizing satellite temperature observations, efforts are particularly required to remove inter-satellite biases arising from a variety of sources such as the calibration nonlinearity, instrument temperature effects, frequency shift, diurnal drift, and limb effect. Effective and accurate bias correction and inter-sensor calibration algorithms need to be developed and tested to merge the ATMS and AMSU-A observations with high accuracy. Efforts are also required to resolve channel frequency differences between SSU and the hyperspectral sounders AIRS/CrIS for their merging.

OUTCOMES: Continuity and sustainability of the satellite atmospheric temperature time series, allowing sustained observations and monitoring of the climate change well into the future.

REFERENCES

Santer, et al., 2017: Comparing tropospheric warming in climate models and satellite data, J.Clim., 30, 373-392.

Zou, C.-Z., and H. Qian, 2016: Stratospheric Temperature Climate Data Record from Merged SSU and AMSU-A Observations, J. Atmos. Oceanic Technol., 33, 1967-1984.

Zou, C.-Z., and W. Wang, 2011:Inter-satellite calibration of AMSU-A observations for weather and climate applications, J. Geophys. Res., 116, D23113

Fu, Q., C.M. Johanson, J.M. Wallace, and T. Reichler, 2006: Enhanced mid-latitude tropospheric warming in satellite measurements. Science, 312, 1179.

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APPENDIX 1: JPSS Proving Ground and Risk Reduction (PGRR) Initiative Best Practices

Version 1.0

This guidance is the written by the Joint Polar Satellite System (JPSS) Program Science Office. Its purposes is to assist Proving Ground and Risk Reduction (PGRR) stakeholders in managing initiatives and realizing PGRR Goals. This document focuses on recommendations for starting new and improving existing PGRR initiatives. This is a living document and will evolve as the JPSS PGRR program moves forward.

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Change Record

TITLE: JPSS PGRR Initiative Best Practices Document				
VERSION	**DATE**	**PAGES AFFECTED**	**CHANGE DESCRIPTION**	**AUTHOR(S)**
1.0	**29 Nov 2018**	**All**	**ORIGINAL DOCUMENT**	**Nazmi Chowdhury**

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1 Scope

This document describes best practices towards meeting JPSS Proving Ground and Risk Reduction (PGRR) Program Initiative (PGI) goals and objectives. Guidance is organized as follows: planning is described in Section 2; stakeholder identification is described in Section 3; execution and user engagement is described in Section 4; and Section 5 focuses on evaluation. Templates for annual plans and quarterly reports and optional team charters are included in appendices.

The establishment of PGRR in 2012, followed the 2011 launch of the Suomi National Polar Partnership (Suomi NPP) satellite. PGRR focuses on maximizing the benefits of Suomi NPP and JPSS data, algorithms, and products for NOAA operational and research users. Proving Ground (PG) facilitates Operations to Operations (O2O), through demonstrations of JPSS derived data and products in user environments to include National Weather Service (NWS), National Ocean Service (NOS), National Marine Fisheries Service (NMFS), Oceanic and Atmospheric Research (OAR), NESDIS, academic community and other external agencies. Risk Reduction (RR) relates to Research to Operations (R2O), via development of new research and applications to maximize the benefits of JPSS satellite data. This encourages fusion of data and information from multiple satellite, models and in-situ data and addresses potential risk in algorithms and data products/processing by testing alternative algorithms and approaches. RR includes improvements beyond the original scope of the JPSS stated requirements. Stood up in 2015, PGI are interagency partnerships of data product developers, operational users, training personnel, and other stakeholders that work towards common goals and objectives addressing NOAA mission challenges. PGIs center on specific mission areas allowing synergy among projects, and collaboration among principal investigators (PI) leading to improved outcomes. The PGI environment allows user assessment and feedback to developers. PGRR projects and all PGIs span the continuum from PG to RR. Although, each PGI has a measure of uniqueness, variation in scope, scale, and approach; a common framework and themes underpinning successful achievement of PGI goals has emerged.

2 Planning

Effective planning sets the stage for PGI articulating achievable goals. This section describes annual planning, user engagement planning for each project and team charters for each PGI. Planning is based on the selected and funded proposals submitted by PIs for each PGI focal area. PGRR projects typically span a three years period of performance.

2.1 Annual Plan

Each Project PI submits an annual plan, including schedule, budget, and risks at the beginning of each performance year using the "JPSS PGRR Annual Plan Template" (Appendix A). Monthly to quarterly milestones along critical paths which affect project deadlines should be included. Dependencies on other projects within and external to each PGI, should be described. Schedules for interdependent milestones in different projects should aligned. Planned milestones should not change during an execution year. Annual plans serve as the basis for quarterly reporting. Individual project annual plans and/or user engagement plans contribute to the overall PGI plan and goals.

2.2 User Engagement Plan

PGIs maintain a user engagement plan, which articulates the ways that operational and research personnel within NOAA line offices and external organizations provide feedback to PI and Algorithm developers. A user engagement plan includes both formal and informal mechanisms to engage stakeholders external to NOAA for feedback. Additionally, a user engagement plan includes success criteria including metrics. User engagement plans will evolve throughout PGI and project lifecycle. Each user engagement plan for each performance year should reflect annual PGI milestones and critical path activities. These plans should be documented using the User Engagement Template in Appendix E.

2.3 Charter

Each PGIs maintains a charter that focuses on goals, boundaries, and lists stakeholders with their roles. Charters state the effective dates. PGI should also develop a set of milestones to meet those goals. The charter should be developed in a group session to encourage understanding and buy-in. Each PGI team assesses whether development of a charter adds value. Charter template and guidance are included in Appendix 3. Charter sections may be modified to fit needs of each PGI.

3 Stakeholders

This document defines the roles and responsibilities of the stakeholders of the initiatives including the initiative facilitator, user advocate, users, developers and principal investigators (PI).

3.1 Initiative Facilitators

Initiative Facilitators are members of the JPSS Program Science staff or user community who are responsible for establishing and maintaining an effective forum for the initiative project teams to interact, facilitate communication between developers and users. They ensure that projects reflect NOAA mission and utilize JPSS data in ways that ultimately lead towards the demonstration of improved applications and where applicable, a pathway to operations.

3.1.1 Responsibilities of Initiative Facilitators

Facilitator provide both science support and project management. Both sets of responsibilities are outlined below. Initiative facilitators should tailor their working styles to each particular initiative

3.1.1.1 Science Support

The science support focuses on ensuring collaboration among the team including a common vision for success; outlining of science and organizational objectives; and bringing challenges into focus. Specifically best practices include:

- Lead the initiative team to define annual objectives and actions needed to meet those objectives.
- Identify opportunities for collaboration between different projects of the initiative as well as maintain awareness of other initiatives to identify leveraging opportunities.
- Identify topics to be addressed by smaller subgroups or outside of the initiative and engage JPSS leadership as needed to discuss any issues and risks identified.

3.1.1.2 Program Management

The program management aspect entails initiating, planning, and executing the PGI with all stakeholders. Specifically best practices include:

- Schedule regular initiative meetings (monthly/quarterly) to encourage routine communication between users and product developers, ensure access to briefing material, and capture action items and status.
- If applicable, integrate milestones from different projects of the initiative into a common master schedule.
- Maintain common document repository
- Maintain awareness of the status of the projects and provide contents to the JPSS Program Science weekly, NOAA JPSS Program Office (NJO) Elements Monthly and other relevant forums.

- Ensure that the projects PIs submit their quarterly reports on time. Review and track the milestones progress from the quarterly reports.
- Work with JPSS PGRR Executive Board to select user advocates for their initiative.
- Communicate key project information to the JPSS Program Scientist, PGRR Executive Board, JPSS Leadership, internal/external stakeholders and the public through outreach such as attending workshops, joint forums, conference presentations and developing web articles.

The JPSS Program Scientist will periodically convene meetings of initiative facilitators and members of JPSS Program Science Office. These meetings serve as an informal forum for initiative facilitators to discuss progress and any concerns about their initiatives. These meetings help initiative facilitators to stay informed about activities and business practices in other initiatives. The goal is to meet at least quarterly.

3.2 Senior User Advocate:

Members from initiatives will actively seek advice and advocacy from senior members of the user communities they support. To be effective, a senior user “advocate” must have detailed knowledge of the policies, leadership, requirements, satellite operational applications, and the specific procedures in NOAA and other governmental communities. The advocate uses this knowledge to help guide the activities of initiative to ensure success. The advocate will look for ways for the initiative to partner with user communities to ensure that the use of JPSS capabilities are consistent and achievable within the user organization’s priorities.

Advocates coordinate the evaluation of initiative capabilities in the users’ operational environments. Capabilities include data, products, innovative solutions and operational applications. The advocate establishes procedures to provides user feedback to the product development teams based on users' needs and expertise. User advocates along with the facilitator collaborate with appropriate operational managers and staffs to determine the best research to operations pathway for proven initiative capabilities. The advocate should attend initiative meetings or assign an alternate representative. An initiative may have multiple senior user advocate from different parts of the user community.

Additionally user advocates educate users about JPSS products and initiative activities. Senior users provide leadership for all users participating in a particular initiative. They represent different segments the user base in order to distill a variety of concerns into coherent messages and objectives.

3.3 Users

Users are anyone that uses (or desires to use) the JPSS data products for operational or research applications. Users should ensure that product applications, product improvements, and methods developed map to organizational needs and if applicable have an operational pathway. Users provide feedback to the algorithm developers for new or improved products, and users should communicate the value (when possible) of using JPSS data products in their applications. Users should also communicate their applications and challenges in their applications so that the PGI members can work to solve those challenges when possible. Users are encouraged to be very vocal about their needs. All the project teams identify their product users. Users should participate in regular initiative meetings as well as the annual review in order to ensure the PGIs are serving the user needs.

3.4 Principal Investigators

Principal Investigators (PIs) propose multi-year projects and define scope, goals, milestones, deliverables of their projects. The PIs have the responsibility to develop annual plans using the JPSS PGRR Project Annual Plan template at the beginning of each fiscal year and ensure that the project team successfully executes their research and development work. The PIs should work with the initiative team to ensure their work is relevant to the user needs.

3.5 Developers

Each PGRR Project may include JPSS algorithm and product developers identified in the funded proposal. Initiative member also identify relevant developers over project life cycles. Developers must have intimate knowledge of JPSS data and products and PGRR capabilities. This helps them communicate the strengths and weaknesses of a product and enables them to make changes to data formats, algorithms, communication channels, and other areas as needed based on user interaction and feedback. They also determine if those changes can be made within reasonable cost. Responsiveness to user feedback will be critical to initiative success. Agile and iterative engagement algorithm developers facilitates product improvement.

4 Execution of Initiative Activities

A successful initiative includes: users and developers exploring new applications together; dialog with other interested parties; collaboration among teams and projects within other initiatives that share common goals; and user engagement in new product development.

4.1 Objectives

Each initiative establishes objectives to address specific user needs and gaps. Initiative objectives should be documented through team charter or other initiative documents and should be relevant to the funded initiative projects. These objectives guide the initiative team's activities. In order to remain relevant, objectives evolve over the Initiative period of performance. Objectives should be defined in a team forum and periodically reviewed. The facilitator helps the team define objectives and success criteria for their initiatives. These objectives allow project PIs to align project plan, schedule and milestones to initiative objectives and goals.

4.2 Communication

The PGI environment encourages communication between users, developers and principal investigators. In this forum, users directly pose their questions to product developers and PIs. PIs and product developers manage expectations through communicating product caveats. Both sides benefit from improved understanding of the products and application in real-world scenarios. This includes communication with internal/external stakeholders and JPSS and other leadership.

4.3 Meetings

Regular initiative monthly or quarterly meetings are organized by a facilitator who represents JPSS Program Office. Each of the initiatives should decide their own standard meeting format that should focus on communicating important factors. Initiatives can also hold separate technical meetings where PIs discuss their research with one another Meetings allow all stakeholders to: communicate opportunities; address and resolve problems; and share their work. PGI meetings creates synergy among the stakeholders, including PIs and users and provide them collaboration opportunities. The meetings establish team cohesiveness and buy-in to common objectives. PGI meetings focuses on: planning demonstrations and evaluations; communicating PGI results; and aligning activities. To maintain momentum, a proactive initiative facilitator invites users and stakeholders to initiative meetings. PIs brief their progress to the users and stakeholders and receive real time feedback from the users. It is important for the facilitator to take actions during meetings and, track them to ensure that team members are held accountable for commitments made.

4.4 User Evaluations

All PGI should have user evaluation. Active engagement between algorithm developers, PIs and NOAA stakeholders enables users to evaluate products and capabilities in operational environments, to tailor to improvements users' requests. Product evaluation exercises involving two or more PIs encourages cross-talk, new ideas and partnerships. All initiatives stakeholders should identify leveraging opportunities to enable participation in NOAA activities such as testbeds, experiments or of field campaigns. Product developers work with the operational users helps understanding the user platform and application.

5 Evaluation

Formal and objective measurement of progress against plan allows all stakeholders, including external reviewers, to understand whether objectives are being met. Evaluation provided information about PGI and PGRR project activities and near term outcomes. The purpose of these activities is to make judgments about program direction, to improve effectiveness, inform programming decisions, and motivate future planning. All funded PGRR project PIs report progress towards meeting goals, plan, schedule in quarterly reports using "JPSS PGRR Quarterly Report Template" (Appendix B). and annual reviews. Reports communicate results of research, demonstrations, and user feedback; analysis of data; and description of issues. The audience for quarterly reporting includes PI, initiative coordinator, user advocate, and JPSS Program Science Office Staff. The audience for annual reviews is broader and may include JPSS PGRR Executive Board; NWS Operational Advisory Team (NOAT); and reviewers such as scientists from other agencies as well as other operational users.

5.1 Quarterly Reports

Each project PI reports progress-to-plan quarterly using the template provided, "JPSS PGRR Quarterly Report Template;" please see Appendix B. This report allows each PI to manage and track their own progress towards their annual plan, identify accomplishments that may be highlighted to JPSS or NOAA leadership, and outline plans for subsequent quarters. This report also includes a project status dashboard and issues and risks section; this allows PIs, Initiative coordinators, and JPSS Program Science Staff to mitigate difficulties as needed. Typically, project annual period of performance spans from the beginning of third quarter of a CY to the end of the second quarter in the subsequent CY. However JPSS Program Science requests that PI begin providing quarterly reports the first full quarter following receipt of funding. Reports can be provided in google document format, word format or pdf format. Reports should be named using the following convention: PGIName_ReportingQuarter_Principal Investigator. The schedule for Quarterly Report submission will be provided prior to each year during project performance.

5.2 Annual Reviews

Annual Reviews allow PIs to have broader exposure to the NOAA community. Reviews provide PIs an opportunity to reflect upon activities during the performance year; incorporate feedback from a broader range of users; and anticipate plans for the next period of performance. NOAA operational managers and other stakeholders will also be further informed about PGRR status and opportunities for O2O and R2O.

Annual Review criteria will be similar to proposal selection criteria. These criteria include but are not limited to:

- Relevance and Applicability of Proposed Projects to PGRR Goals including: NOAA mission, potentially to advance satellite data use, project evaluation plan, transition to operations, utility to public
- Technical and Scientific Merit: This criterion assesses whether the approach is technically sound and/or innovative, whether methods are appropriate, and whether there are clear project goals and objectives
- Outreach and Education: This criterion assesses whether the project provides a focused and effective education and outreach strategy regarding NOAA's mission areas

JPSS Program Science Staff will provide schedules, guidance and templates closer to annuals reviews.